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TAMPERE UNIVERSITY OF TECHNOLOGY

MUSTAFA KAMAL

ANALYZING MARKET POTENTIAL WITH INDUSTRY AND TECHNOLOGY EVOLUTION MODELS

Master of Science Thesis

Examiner: University Lecturer Jouni Lyly-Yrjänäinen and Associate Professor Leena Aarikka-Stenroos
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ABSTRACT

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In today's challenging business environment, many companies are looking for opportunities for organic growth. One of the most common ways is by market expansion: looking for new geographical regions to sell their products in. This approach requires investment of time, money and resources, which makes evaluating the new segment extremely important. Traditional methods include sales forecasting which can act as a good measure to make strategic decisions. However, they can be static in nature and do not take into account the industry and technology levels of a developing country.

The objective of this thesis is to utilize technology and industry evolution models to perform a more in-depth analysis of market potential for developing countries. Taking this approach allows the development of a framework that looks into evolving markets and finding the right products to sell which match the technology level in the target area. The life cycle models also provide an excellent source of information regarding future potential.

This study shows that technology and industry evolution models provide a very effective means to evaluate developing markets. The gap between developing and developed countries is utilized to judge which industries and technologies offer the most potential in Pakistan. It also serves a basis to judge which products and applications should be left for later when the technology level increases as the industry in the developing countries grows. This study has been limited to comparisons between industries in Finland and Pakistan.

PREFACE

I have always had a lot of interest in evaluating market potential and business development. When I heard that the case company was looking for someone to help them look at new geographical markets after their success in India, I offered to study Pakistan in light of their product offering to find the business potential for their organization. The results of the thesis surprised the case company given the huge business potential, and things have moved to the next stage where they are looking for potential suppliers to sell their products in the country.

While working at the case company I learnt many interesting aspects of business development which I was unaware of before beginning the thesis project. I had the opportunity to learn how to collect data and then filter it to isolate usable and reliable information to generate valuable insights for business development.

I would like to thank Dr. Jouni Lyly-Yrjänäinen for his continuous support throughout the duration of the project work and helping me find the case company to write my thesis. I would also like to thank the management at the case company for taking time out for me from their busy working hours. Lastly, I would like to thank my parents, without them it would not be possible for me to be here in Finland today.

Tampere, 23.7.2018

Mustafa Kamal

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1. INTRODUCTION

1.1 Background

Business expansion is the long-term strategy of successful organizations and organic growth is one of the key means to achieving it (Proctor, 2008). Grant (2016) discusses other means of growth like business acquisitions, mergers, and alliances which are external growth strategies when firms want to achieve major extensions in the size and scope of their activities in a rather short period of time. Organic growth is what most companies aim for if they do not want to scale too aggressively.

Market expansion strategy is a strategy that many small to mid-sized firms utilize to push their current product offering to new geographical markets (Proctor, 2008). The challenges that are faced when looking to expand to new geographical locations where they do not have a presence requires a market study to identify the potential of the region, which is usually done by demand forecasting (Blocher et al., 2004) The advantages of performing a demand forecast are well documented, ranging from better strategic decisions to improved supply chain performance and customer satisfaction.

However, while a demand forecast offers significant advantage, it also can cause huge financial setbacks to a company if strategic decisions are made on a bad or inaccurate forecast (Blocher et al., 2004). Another thing worth noting is that forecasts usually are very static in nature as they do not take into account the changes that may be occurring in the overall industry and technology level in a region. Hence, even if a forecast is accurate, there is no guarantee that the potential will not go down or up in the following years.

Time, money, and resources that need to be dedicated when expanding to a new market segment, make it very important for companies to make sure that the investment is viable and will return the money that they have put into the expansion project. Some managers may rely on intuition to make decisions, others rely on strategic methods of analysis (Akhter, 2015). While forecasts are an excellent means to use as a foundation for making strategic decisions regarding, a more in-depth study of the market segment can be useful to understand the industry to which the products will be sold. It has been well documented that strategic decisions that are made with systematic analysis of customers, markets and competitors tend to fare better in the competitive market place (Akhter, 2015).

1.2 Objective

This thesis introduces a new way to evaluate a market segment to analyze its market potential. It can be extremely valuable for a company to see the trends of industry maturity and technology level in the target industries of the chosen geographical market where they will be expanding to. This would allow for improved decision making as the future and present demand can be seen which would reduce the risk of investment.

Technology and industry evolution models are great tools to evaluate trends in industries. These generic models are applicable to almost all industries and geographical markets and are supported by empirical evidence which makes them an excellent basis for practical work (Porter, 1980). They also act as an excellent basis for making strategic decisions, as they provide information regarding competitors, production, sales, and more. Informed decisions made based on knowledge of the market being entered tend to be more successful (Akhter, 2015).

These models and industrial behavior are well documented and researched which allows them to be used for analyzing markets and trends. Sabol et al. (2013) states that despite a lot of research on the topic the models developed by Porter (1980) remain the corner stone of the life cycle analysis. Most advanced technologies tend to originate in developed countries and are then acquired by developing countries through knowledge diffusion with a time lag (Fagerberg, 1987). This adds a new dynamic to studying market segments. Expanding to a new geographical location, which might be a developed country, would be easier as they tend to be on the same technology level and are capable of utilizing the value offered. On the other hand, developing countries tend to lag behind technologically, this can result in them not being able to fully utilize the value being offered. Thus, the objective of this paper is…

> *… develop a tool to analyze the market potential of a new geographical segment by utilizing industry and technology evolution models in developing and developed countries*.

To address this objective, this thesis reviews scientific literature regarding estimating demand, industry evolution, technology evolution, and value proposition. Using this literature, a framework for industry and technology lag between developing and developed countries is developed. Finally, this framework is then tested using empirical data from the industry in Finland and Pakistan.

1.3 Research Process

The research process was unofficially kicked off on 21st February 2018 when the author started generating ideas for the thesis in the field of business development. The case company was interested in a business development project because of the recent success of their products in India. Common interest towards the project lead to the author to start writing the thesis for the case company and get involved with more practical work in the Finnish industry and hence, build a stronger profile for future employment opportunities.

In the first week of March it was decided that the scope of the thesis should be limited to market analysis of Pakistan. The entire month of March 2018 was dedicated to analyzing the case company's products and generating a detailed list of potential companies in Pakistan, given its similar economic nature to India where the case company had recently reported considerable success in. Data regarding production figures and competitors in the pulp and paper industry was collected and analyzed.

On April 6th, the first presentation was given to the CEO of the case company where a study showing the pulp and paper industry in Pakistan was presented, along with a list of major players in the food, beverage, and chemical sectors. It was decided that despite the growing potential of pulp and paper in Pakistan, the overall industry was too small to focus on and the target was shifted to other industry sectors where the case company had product applications.

The months of April and May were spent on developing the theoretical framework and collecting data regarding the food and beverage industry in Pakistan. The sugar and dairy industry were focused on as they were identified as the industries with the biggest potential based on the case company's product offering and sales history.

During this period, data was gathered from public resources regarding the production figures of sugar and dairy industry in Finland and Pakistan. The number of competitors in Pakistan was analyzed to develop a clear picture of the current industry level of the sugar and dairy sector. Based on this, the first estimate of the market potential was developed. Due to the presented analysis and potential of sales in Pakistan at the case company, it was decided that the Sales Manager for the food and beverage division would be involved to move the process forward.

The next meetings were on 13th and 18th of June at the case company with the Sales Manager. The focus of these meetings was on collecting information regarding the key technologies and applications that could be focused on depending on the technology level in the dairy sector since the case company expressed interest in focusing on the sector first before moving onto the sugar industry. Due to this the technology applications for the sugar industry were not included in the empirical work of the thesis. However, the technology level was still analyzed as it was a part of the developed framework. These evaluations were then incorporated into the thesis to further the research process regarding which products and applications should be the focus to start the sales process in Pakistan.

The casework has moved past the thesis, and meetings with a distributor in Pakistan have already been scheduled, indicating the success of the thesis in practical terms. The figure below shows the general overview of the research process.

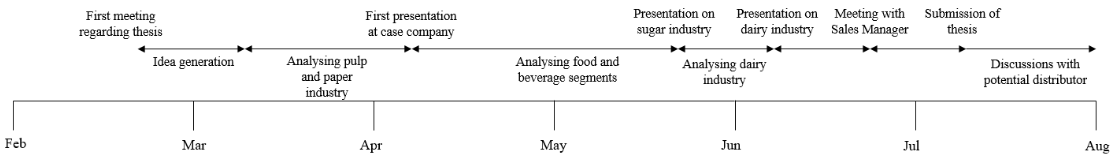

Figure 1. General overview of research process.

In the figure above the thesis timeline can be seen. The important milestones are marked above the line, while the research process between those milestones is stated under the line. As mentioned earlier, the thesis has moved onto practical stages of implementation by looking for potential distributors in the region and negotiating terms and conditions for market entry with a focus on the dairy sector.

1.4 Data Gathering Methods

Research is defined as a methodological and systematic process in which existing knowledge is increased or new knowledge is created by investigation (Amaratunga et al., 2002). Data forms the basis for performing research. The procedural framework within which research is performed is called the research methodology (Remenyi et al., 1998).

Research can either be theoretical or empirical in nature (Moody, 2002). Theoretical research consists of investigating existing hypothesis and theories in scientific literature to answer a research question or create a theoretical framework. Empirical research, on the other hand consists of data gathering methods and analyzing the collected empirical data to report the findings (Minor et al., 1994).

Moody (2002) divided empirical research methodologies into quantitative and qualitative methods. Qualitative methods are better used in the early stages of empirical work, while quantitative methods are suitable for theory testing and improvement. Gummesson (1993) categorized data gathering methods into five methods for case study research. These methods are shown in the table below.

Table 1. Data gathering methods.

Method	Description
Existing Material	Books, Articles, Mass Media Reports, Brochures, Films.
Questionnaire Surveys	Formalized and standardized interviews.
Questionnaire Interviews	Informal interviews. Open ended questions.
Observation	Non intrusive. Observing subject of the study.
Action Science	Total involvement of the researcher and can contain all other data gathering methods.

The figure above shows the data gathering methods and a brief description of what each of the research methodologies involves. The goal of the thesis was to create a theoretical framework which could then be applied to the case company to analyze a developing market for potential business opportunities.

Initially, data and information was gathered from the company website, brochures and sales material. The theoretical framework was first tested using information from the pulp and paper industry from Finland and Pakistan before applying it to the food and beverage industry. Data for the case study was collected using existing material, informal interviews, and action science. Several visits were made to the case company's production facility and information was collected from the CEO and Sales Manager through information interviews. The table below shows the data gathering methods in different stages of the research process.

Table 2. Research methodologies for each process in the thesis.

Research Process	Research Methodology Used
Idea Generation	Existing Material, Observation
Analysing Pulp and Paper Industry	Existing Material, Informal Interviews
Analysing Sugar Industry	Existing Material, Informal Interviews
Analysing Dairy Industry	Existing Material, Informal Interviews

Since the thesis wanted to ensure that no important information from the case company was leaked to their competitors, the data gathering methods were restricted to public sources of information or information available on the case company's website and brochures. The analysis stages for the pulp and paper, sugar, and dairy industries also involves the data collection process from scientific literature and publicly available information published by government organizations that keep track of industry specific data.

1.5 Structure of the Thesis

This thesis has been divided into 9 Chapters. The content and objectives of each chapter are as follows:

1. Chapter 1 provided a background for the thesis and the objective. It also explained the thesis research process and data gathering methods.

2. Chapter 2 discusses the industry evolution models. It starts off by explaining the importance of demand and the traditional method of demand forecasting to analyze market potential. It then moves onto discussing literature of the industry life cycle model.

3. Chapter 3 discusses the technology evolution models. It reviews literature regarding the two most popular models of technology evolution and discusses the technology adoption model in more detail; as it is the one utilized to build the theoretical framework of the thesis.

4. Chapter 4 briefly discusses value proposition. Value proposition is discussed in light of current literature to provide insight on determining the right technologies to sell at the right time.

5. Chapter 5 builds the theoretical framework for the thesis. It uses the technology and industry evolution literature reviewed earlier to build a model for time lag between industry and technology life cycles in developing and developed countries.

6. Chapter 6 discusses the case company and their products. The product offering of the company is explained and the main applications in their target industry sectors.

7. Chapter 7 analyzes Pakistan, the target of the research study for the case company, to find out the potential of the new geographical market. It first tests the theoretical framework using the pulp and paper industry by comparing Finland and Pakistan. Then the food and beverage industry is analyzed using the developed framework, specifically the sugar and dairy industry.

8. Chapter 8 focuses on discussions and lessons learnt. The reflection of the work and results is elaborated on and the use of the theoretical framework to analyze the case is described.

9. Chapter 9 wraps up the thesis. It summarizes the key findings and gives suggestions regarding future research work regarding the framework built in the thesis.

2. INDUSTRY EVOLUTION

2.1 Understanding Demand and Analyzing it

Demand and supply are a fundamental part of economics and are used to set a price based on the product or service availability (Ball & Seidman, 2012). Supply is defined as the product, service, or experience that is being provided. Demand is defined as the desire to acquire the product, service or experience (Samuelson and Nordhaus, 2010).

The law of demand states that if all other factors remain equal, the price and demand would be inversely proportional. The law of supply states that the higher prices will lead to higher supply. Combining these two laws are called the law of supply and demand (Samuelson and Nordhaus, 2010). Equilibrium is the point at which supply and demand are equal. The point of equilibrium carries importance as suppliers and consumers both are satisfied (Rogers and Ruchlin, 1971). The figure below illustrates supply, demand and equilibrium.

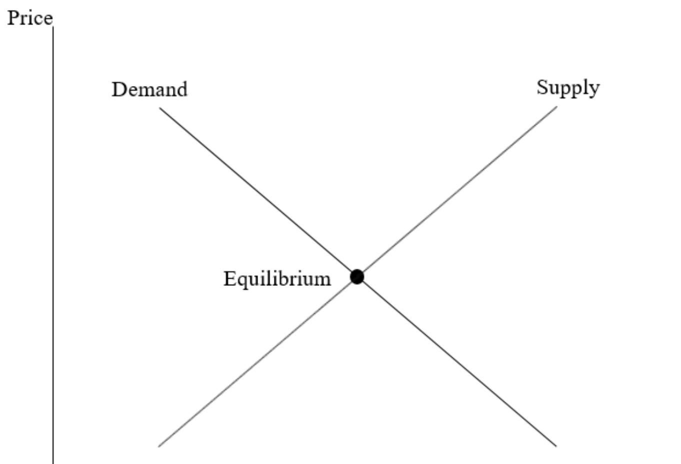

Figure 2. Demand, Supply and Equilibrium.

The ability of a consumer to buy a certain product, service or experience depends on their level of income which is disposable. Usually, the demand in a certain consumer market is proportional to the consumer's level of income (Begg & Ward, 2009). In most developing countries, as the economies grow, there is an increase in demand of products and services due to increasing disposable income (Mulma, 2011). The increase is demand has to be matched with an increase in supply following the law of supply and demand.

Countries manage supply by regulating domestic production and imports in order to meet the local demand (Vercammen & Schmitz. 1992). The combined theories discussed by Samuelson and Nordhaus (2010), Begg & Ward (2009), and Vercammen & Schmitz (1992) are illustrated in the figure below.

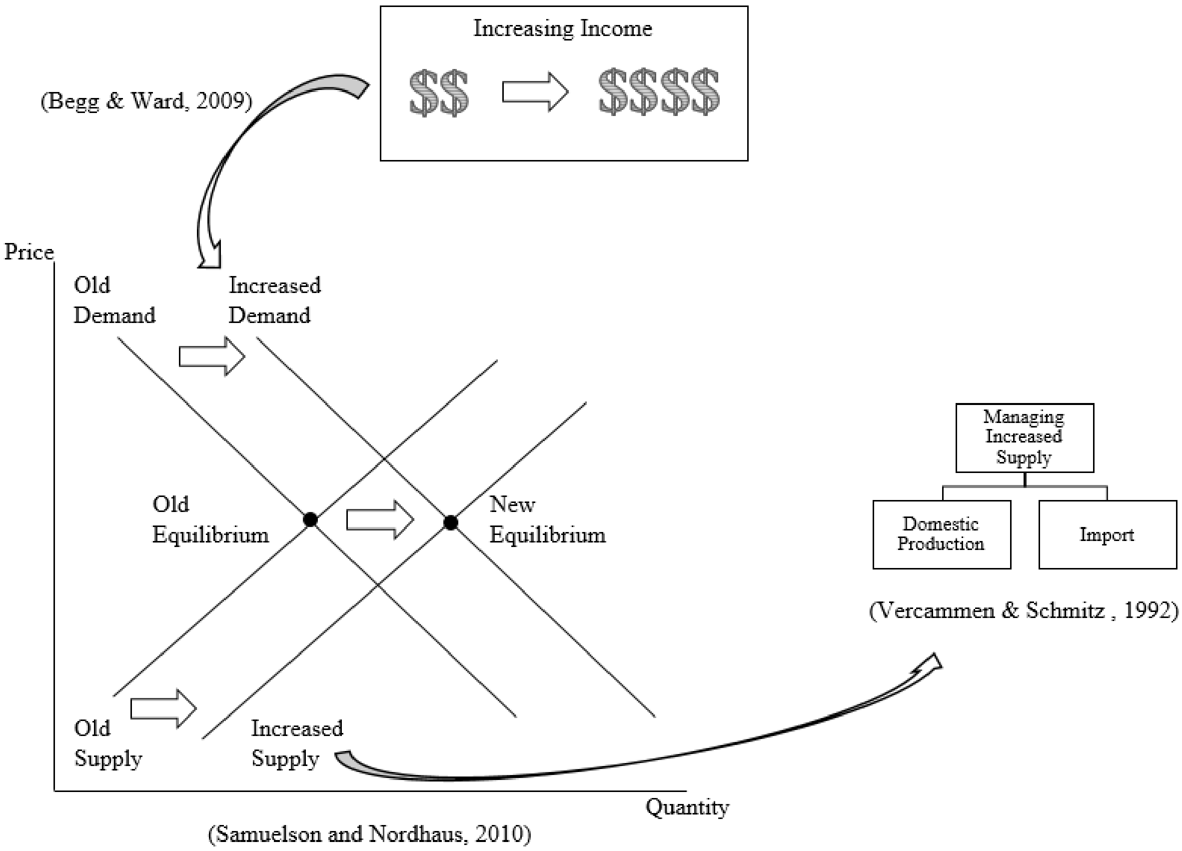

Figure 3. Impact of increasing demand and catering to it.

The figure above illustrates the concepts discussed earlier. The increasing level of income in a developing country leads to an increase in demand for products, services, and experiences. An increase in demand in turn results in a need for increased supply. The increased supply can be met by two possible ways which are increasing domestic production or through importing what is required.

Due to an increasing level of global competition, there is an increasing number of products and services being offered across the world (Fisher et al., 1994). This increase in global competition makes demand forecasting a very important tool for all industries, as history is filled with companies that have made huge strategic mistakes of demand forecasts leading to large financial losses (Barnett, 1988). The benefits from demand forecasting have been discussed by several authors, the table below summarizes the benefits that have been high-lighted by different authors.

Table 3. Benefits of demand forecasting.

Author	Benefits							
	Improved Strategic Decisions	Improved Production Planning	Reduced Inventory	Reduction in Lost Sales	Improved Supply Chain Performance	Improved Service Levels	Improved Customer Satisfaction	Improved ability to identify disruptive changes
Fisher et al. (1994)		x	x	x			x	
Barnett (1988)	x							x
Sadarangani & Gallucci (2004)				x				
Aviv (2002)		x	x		x			
Vogel (2014)						x	x	
Blocher et al. (2004)	x	x	x	x	x	x	x	

The table above sums up the many aspects of demand forecasting which are beneficial for a company. It can be seen that all these benefits result in financial gain to the organization performing the forecast. A demand forecast can be an excellent source of information to estimate the overall potential of a new geographical market segment and to allow managers to make decisions regarding investment of time and money to expand to the new region.

However, it is important to keep in mind that these benefits are gained when the forecasting done is accurate in nature. Inaccurate forecasts can severely damage a company due to bad strategic decisions which could lead to huge financial losses (Barnett, 1988). As demand forecasts are a critical part of making strategic decisions, it is important to follow an organized approach to determining it as accurately as possible. Barnet (1988) describes four steps needed in making any total-market forecasts:

- Defining the market
- Splitting the total demand in the industry into its main components
- Forecasting the demand drivers and then understanding how they will change in the future
- Conducting a sensitivity analysis of the critical assumptions

First, the market must be defined. In the beginning, it is better to be inclusive and define it broadly enough to include all the potential end users (Barnet, 1988). Developing a market segment is a technique of marketing management mainly used to develop competitive advantage (Proctor, 2008). When developing a market segment, it is important to understand that it should be large enough to generate viable financial advantage when targeting a group (Wind & Douglas, 1972). Defining the market should include all possible end users (Barnet, 1988). Proctor (2008) proposes market segmentation techniques to follow the use of different variables:

- Geographic segmentation
- Demographic segmentation

- Geo-demographic segmentation
- Psychological segmentation
- Behavioral segmentation

Geographic segmentation is division revolving around continents, countries, cities or small regions and locations like towns, villages and streets (Wedel & Kamakura, 2010). The demographic segmentation is done by utilizing social statistics like gender, age and income level (Reid & Bojanic, 2009). Geo-demographic is a crossover between geographic and demographic segmentation and is done by mixing of data from both (Kotler & Keller, 2006). Psychological segmentation is done by profiling people psychologically using things like life-styles, personality traits and attitude (Kotler & Armstrong, 2010). Behavioral segmentation is done by using patterns in behavior towards a product or service like heavy and light users (Proctor 2008).

Second, the total demand must be split and divided into small homogenous parts. Each sub-category must be so that the demand drivers apply in a regular way across them and should be large enough to ensure that it is worth the time and effort to analyze them (Barnet, 1988). Kotler (2000) states that in order for a market segment to be rated favorable it must meet five criterion which are:

- Measurable
- Substantial
- Differentiable
- Accessible
- Actionable

First, the overall size and the characteristics of the segments should be large enough that they can be measured. Second, the segments must be profitable enough to be financially viable. Third, the segment should be conceptually differentiable. Fourth, the segment should be accessible, meaning it should be possible to reach it and serve it. Fifth, it should be possible to attract and serve the segment through plans that would be designed.

The five-criterion discussed by Kotler (2000) can be applied to the sub-categories division that are proposed by Barnet (1988). The figure below illustrates how demand can be divided into sub-categories using the example of white paper.

Table 4. Dividing demand into sub-categories.

Sub-Categories	Percentage of Total Demand
Printing Paper for Offices	25
Printing Paper for Industry	20
Printing in Commercial use	20
Books	15
Magazines	5
Brochures	5
Labels	5
Stickers	1 or less
Catalogues	⬇
Inserts	

Total Demand

80% of Total Demand

In the figure above an example of white paper has been used, and it can be seen that the top 4 sub-categories/sub-segments together make 80% of the total demand. Sadarangani & Gallucci (1994) state that forecasting can be a demanding activity and quite time consuming. By using the five criterions, it is more strategically and financially viable for the company to focus its resources on the top four categories that are responsible for generating 80% of the demand.

Third, the drivers of demand are identified and then forecasted. Demand drivers are elements that have the highest impact on the accuracy of a forecast (Sadarangani & Gallucci, 2004). Demand forecasting is the use of methods and techniques to identify demand in the future (Ritchie & Goeldner, 1987). Fisher et al. (1994) highlighted many advantages of forecasting demand which include being able to plan production better, reduce inventory levels, better strategic decisions, and reduction in lost sales (Sadarangani & Gallucci, 2004) which all lead to financial advantage.

In the last section, the importance of disposable income and its impact on demand was highlighted. Income is only one of the factors that can have an impact on the demand of a product, service or experience (Mulma, 2011). Demand is affected by both macroeconomic variables and industry specific developments (Barnett, 1988). The table below gives a list of macroeconomic demand drivers identified by different authors.

Table 5. Drivers of Demand.

Demand Driver	Samuelson & Nordhaus (2011)	Rittenberg & Tregarthen (2009)	(Lipsey & Harbury, 2004)	Barnet (1988)	Dilts (2004)	Mulma (2011)
Average Income	x	x	x	x		
Total Population	x	x	x	x		
Personal Taste of Consumers	x	x				
Price of Associated Goods	x	x	x		x	
Special Interests	x	x			x	
Future Expectations of Price						x

The table above shows the macroeconomic demand drivers identified by different authors that have the potential to impact different industries. As the average level of disposable income goes up, so does the demand (Lipsey & Harbury, 2004). An increasing total population means a higher number of people in the market that is being studied which results in higher demand (Rittenberg & Tregarthen, 2009). Personal taste of the consumers can have an impact on demand, as perceiving a product as a status symbol can have an influence on it (Samuelson & Nordhaus, 2009). The price of goods and services associated with the product that is being studied can have an impact on its demand (Dilts, 2004). Special influences refer to alternatives that are available for using the product and their impact on the total demand of the product (Samuelson & Nordhaus, 2009). Fluctuations in the future price of a product may cause a shift in demand: lower price in the future than at present could cause people to hold out on buying and then purchase more when the price drops (Mulma, 2011). The figure below illustrates how demand drivers can result in a shift of the demand curve.

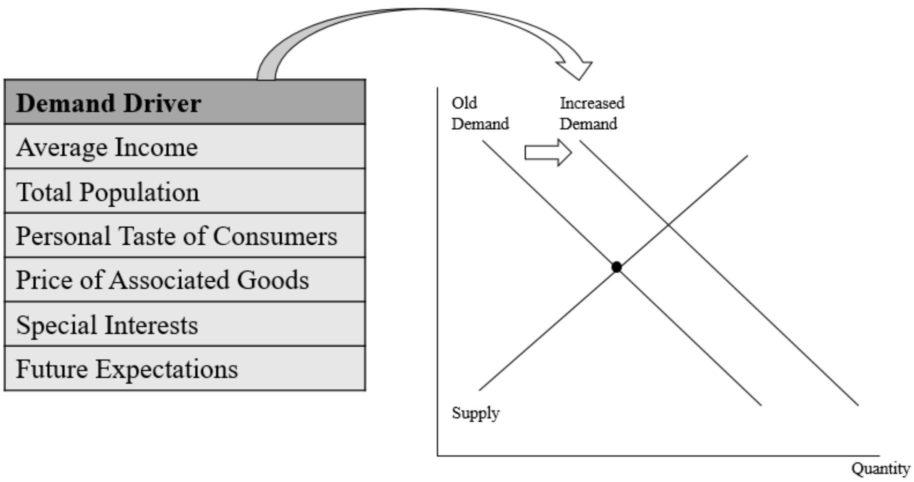

Figure 4. Demand drivers shifting the demand curve.

After identifying the drivers of demand, they are applied to the sub-categories from the second step. Finarelli & Johnson (2004) state historical data should be collected and analyzed. Using historical data and merging it with forecasts can give a more wholesome view of trends.

Fourth, a sensitivity analysis needs to be performed. Once the drivers have been identified and their impact has been estimated, it is important to see how far it could be off-target

(Barnet, 1988). Sensitivity analysis can be defined as the study of how the output uncertainty of a mathematical model or a framework is in proportion to the input uncertainty (Saltelli, 2002).

The importance of performing sensitivity analysis is supported by Hornberger and Spear (1981) by stating that developed models can have many degrees of freedom while being complex and non-linear so by fiddling with it any desired result can be illustrated. Since the forecasts can have a large financial impact on a company, it becomes valuable to evaluate the forecast models to judge their robustness (Wind & Douglas, 1972). The steps stated by Barnet (1988) are listed in the table below.

Table 6. Carrying out a sensitivity analysis.

Step No.	Actions
1	Quantifying the greatest strategic risks.
2	Gauging the likelihood of the quantified risks.
3	Creating scenarios based on identified risks playing out.

The table above shows the steps needed to conduct a sensitivity analysis on the forecast developed based on the drivers and their impact on demand. Since the effort and time needed to perform such an analysis is quite large (Sadarangani & Gallucci, 1994) it is important to assess the depth of carrying out the exercise in light of how useful it is to make the decision at hand (Barnet, 1988).

When trying to analyze demand for a technology that supplements another product, the concept of derived demand becomes important. Hirschey (2009) defines derived demand as the demand of input goods and services to produce the output. The demand of the goods and services being used as input is dependent on the final product's demand, hence being called derived demand.

Schlicht (2006) states that most demand in an industry is actually derived demand because it is based on the demand of some other product or service. Marshall (1950) and Hicks (1948) discuss derived demand in a production environment highlighting its importance for a supplier. A simple example that can be used to illustrate this is tractor sales. Muth (1964) discusses earlier studies conducted on the topic and then takes it a step further by applying the concept to other areas of business like real estate and property. Since a clear relationship is identified by the authors regarding the demand of a supplier's product/service and the supplier's supplier products, it becomes increasingly important to monitor demand for all members in the supply chain. An estimation of demand and forecasting can lead to improved production planning and reduction in inventory while simultaneously improving service levels for customers (Vogel, 2014). The figure below illustrates the concept of derived demand using the example of the paper industry.

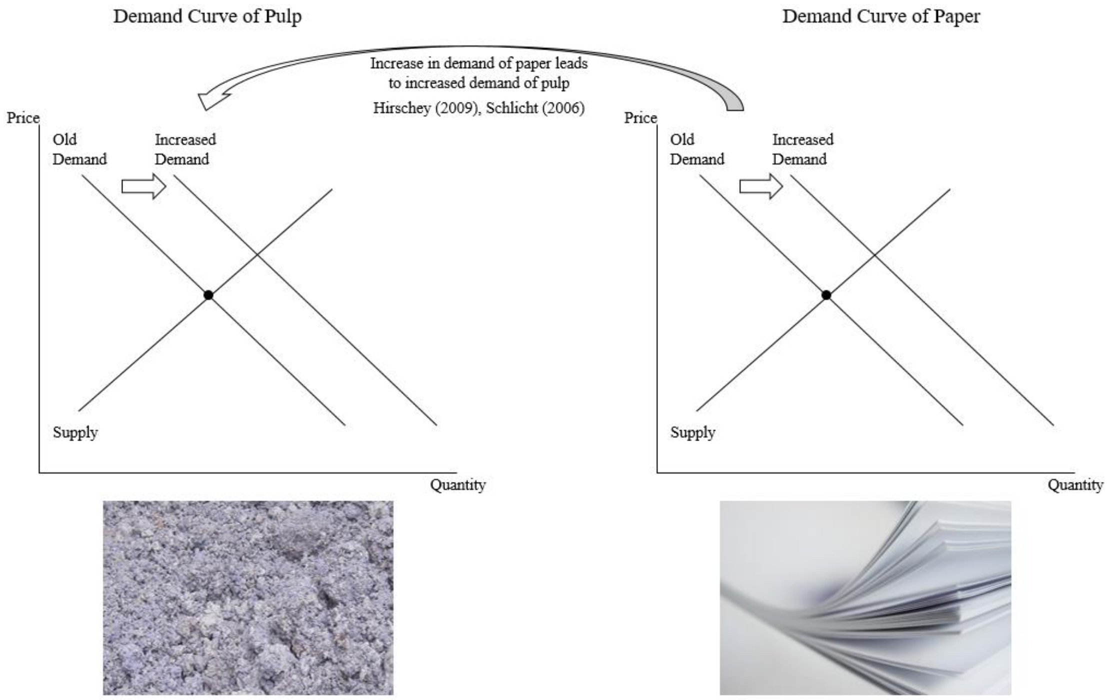

Figure 5. Derived demand in the pulp and paper industry.

The figure above shows the impact that is caused by one industry on another. The increased demand of paper causes an increase in demand for pulp, which is used to manufacture paper. This supports the argument discussed earlier thus highlighting the importance for demand forecasting as the demand for the pulp is directly impacted by the demand for paper. The pulp industry can plan for increasing or decreasing their production based on the forecasts for the paper industry. Forecasting the demand in the future is called demand planning (Kilger & Wagner, 2008). The demand forecast for the company the supplier is doing business with can be used with adjustment by applying proportionality to develop a demand forecast for their own products (Muth, 1964). The figure below further builds on the concept of demand forecasting and derived demand.

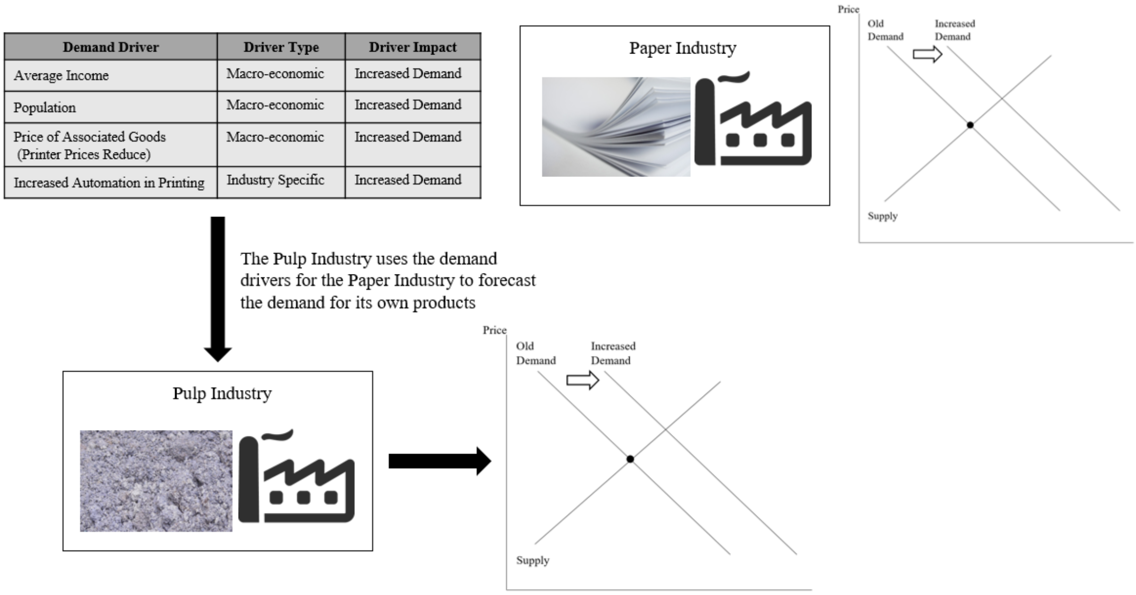

Figure 6. Using demand drivers for the paper industry to forecast pulp sales.

The figure above shows the impact of the demand drivers like average income and population increasing while the printer costs and automation goes up, causing the overall demand for paper to rise. As Muth (1964) stated, the demand for pulp rises to meet the increasing need to produce more paper. The dependence of the industries on each other allows the pulp industry to utilize the demand drivers for the paper industry to develop its own forecasts.

This section highlights the importance of demand plays and the role it plays in sales forecasting. It covers concepts like supply and demand, demand forecasting and understanding derived demand. Since the thesis focuses on market entry into a new geographical location, the industry and technology evolution models will be analyzed in the next sections and chapters to establish a more sophisticated method to analyze the market segment and understanding demand.

2.2 The Industry Life Cycle

Industry evolution is critically important for formulation of strategy regarding investments and its attractiveness (Porter, 1980). Managers and executives from many different industries utilize the industry life-cycle model to take a guided approach to investment (McGahan et al., 2015). Porter (1980) highlights the importance of using the product life-cycle model to chart the course of industry evolution by stating:

> "*The grandfather of concepts for predicting the probable course of industry evolution is the familiar product life cycle. The hypothesis is that an industry passes through a number of phases or stages: introduction, growth, maturity, and decline"*

The model of the industry life cycle discussed by Porter (1980) has since then become a corner-stone for topics regarding strategic management. Industries go through different life-cycle stages over time and these stages are marked by differences in investment, re-structuring activity, general strategies, and competition (Gort & Klepper, 1982; Jo-vanovic, 1982; Klepper & Grady, 1990; Klepper, 1996). The figure below illustrates the industry life cycle and its four stages.

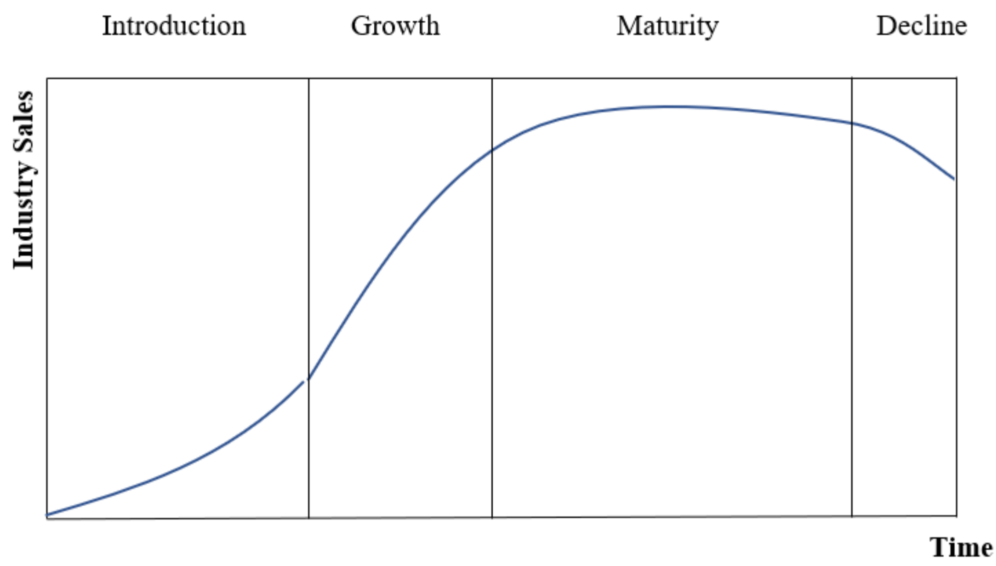

Figure 7. The industry life-cycle and its stages.

The figure above shows the course of industry evolution using the product life cycle model as proposed by Porter (1980). First, industries begin in a period of fragmentation as companies start with experimentation and trying different approaches (McGahan et al. 2004). In the introductory phase, most firms are perusing product innovations, production flexibility is often high, and manufacturing plants are small and close to customers (Sabol et al., 2013). The overall industry sales grow slowly in this phase (Porter, 1980).

Second, in the growth phase a scalable approach becomes the dominant model in the industry (McGahan et al., 2015). There is a reduction in product variations and there is a shift from product innovation to process innovation and there is an increase in automation (Sabol et al., 2015). Firms that fail to keep up with the changes and adjustment to the dominant model are forced to exit (McGahan et al., 2004).

Third, the industry reaches a stage of maturity. It becomes difficult for firms to further improve productivity and innovate the process, and volume growth in sales hits a dimin-ishing return which marks the entry into the maturity stage (McGahan et al., 2004).

Fourth, decline is the last stage of industry evolution. There is a reduction in sales volume with time which marks the last phase: decline (Porter, 1980). The reason behind the de-cline in volume is often saturated demand of an exhausted supply (McGahan et al., 2004).

This phase is marked with low level of innovation in both products and processes (Sabol et al., 2015).

Despite the popularity, there has been criticism about the use of the life cycle model to chart the course of industry evolution. The table below shows for and against arguments presented by authors regarding the industry life cycle model.

Table 7. Criticism and support of the life cycle model.

Criticism of Model	Support of Model
Every industry will not pass through each stage (Porter, 1980)	Offers interesting insights and predictions to entry, competition, profits and exit (Greer, 1992)
It may not be clear where an industry lies in the life cycle model (Porter, 1980)	Models motivated by empirical regularities observed in data (Gort & Klepper, 1982) (Klepper & Grady, 1990)
Evolution and industry competition may vary for specific industries (McAuliffe, 2006).	Analytical approach to anticipating patterns in industry changes (Porter, 1980)
The duration of the four phases may vary widely (Porter, 1980)	Identifies key strategies for survival of firms during industry evolution (Sabol et al., 2013)
Companies can affect the shape of the growth curve by production innovation or repositioning (1980)	

The table above highlights the issues identified by different authors regarding the usage of a life cycle model to chart the course of industry evolution. Despite the critics, the support of empirical studies carried out by Gort & Klepper (1982) and Klepper & Grady (1990) shows that data supports the model and ability to identify strategic advantages may result in the survival of a firm as the industry evolves.

A significant amount of research has been done regarding strategy formulation, competition among firms, and company performance during the different phases of the industry life cycle. The table below summarizes previous literature regarding key functions in an organization and how they are impacted by the different stages of industry evolution.

Table 8. Buyers and products in the industry life cycle (Adapted from Porter, 1980).

	Introduction	**Growth**	**Maturity**	**Decline**
Buyers	Purchasers usually have higher income (Staudt et al., 1976) There is buyer inertia (Levitt, 1965) Buyers must be convinced to try out the product (Levitt, 1965; Staudt et al., 1976)	The buyer gap begins to widen (Staudt et al., 1976) Uneven quality is acceptable (Patton 1959) Technical and performance differentiation in products (Forrester, 1959)	There is a mass market (Smallwood, 1973) Market Saturation (Levitt, 1965) Market Saturation and repeat buying (Levitt, 1965) Superior quality (Porter, 1980)	Customers understand products well (McGahan, 2004)
Products	Focus on product design (Clifford, 1965) Many variations in products (Porter, 1980) The design changes frequently (Wells, 1972) Product designs are basic (Smallwood, 1973)	The key is product reliability (Porter, 1980) Competitive product improvements (Staudt et al., 1976) Quality improved (Porter, 1980)	Product differentiation reduces (Buzzell. 1966; Dean, 1950; McGahan, 2004) Increased standardization (Dean, 1950) Reduced changes in products (Patton, 1959)	Less product differentiation (Sabol et al., 2013)

The table above shows the behavior of buyers and the changes in products in the four phases of the industry life cycle. With each stage the buyer knowledge improves, and the product quality goes up. The table below compares the difference between the marketing and distribution in the four phases.

Table 9. Marketing, manufacturing and distribution in the industry life cycle (Adapted from Porter, 1980).

	Introduction	**Growth**	**Maturity**	**Decline**
Marketing	Advertising costs are high (Buzzell, 1966; Forrester, 1959) The marketing costs are high (Staudt et al., 1976)	Advertising costs remain high (Buzzell, 1966; Forrester, 1959) Advertising and distribution plays a big role in sales of non-technical products (Clifford, 1965)	Market segmentation becomes important (Smallwood, 1973; Levitt, 1965) Efforts to extend life cycle (Buzzell et al., 1972) Providing services and deals becomes common (Levitt, 1965) Low advertising (Buzzell, 1966)	Low advertising (Buzzell, 1966)
Manufacturing & Distribution	Overcapacity (Porter, 1980) Short Production Runs (Wells, 1972) High production costs (Sabol et al., 2013) High flexibility (Sabol et al., 2013)	Under capacity (Smallwood, 1973) Shift towards mass production (Sabol et al., 2013) An increase in distribution channels (Staudt, 1976)	Capacity optimized (Porter, 1980) Manufacturing processes stabilized (Catry & Chevalier, 1974; Sabol et al., 2013) Distribution channels try to improve margins (Staudt et al., 1976)	Over capacity (Smallwood, 1973) Products produced in mass (Forrester, 1959)

The table above highlights the differences in marketing, manufacturing and distribution in the four phases of the industry life cycle. Advertising costs start to go down as the market enters the stage of maturity. Manufacturing takes a shift towards mass production and eventually results in over capacity as the industry goes through the phases. The table below compares the R&D, overall strategy, competition and risk in each phase of the cycle.

Table 10. R&D, strategy, competition and risk in the industry life cycle (Adapted from Porter, 1980).

	Introduction	Growth	Maturity	Decline
R&D	Changing production techniques (Wells, 1972) Product R&D (McGahan, 2004)	Process R&D (Sabol et al., 2013)	Focus on Extending life-cycle (Sabol et al., 2013)	
Overall Strategy	The best time to improve market share (Catry & Chevalier, 1974) R&D is the most important aspect (Porter, 1980)	Focus on price and quality (Patton, 1959) Marketing is the most important aspect (Porter, 1980)	Bad time to increase market share if the company has a low market share (Catry & Chevalier, 1974) Competitive costs should be the focus (Porter, 1980)	The costs should be controlled (Clifford, 1965)
Competition	Few (Levitt, 1965; Wells, 1972)	Many (Levitt, 1965; Wells, 1972) Mergers, acquisitions and quitting (Porter, 1980)	Many companies drop out due to not adopting the dominant design (Sabol et al., 2013)	Few competitors (Sabol et al., 2013)
Risk	High (Levitt, 1965)	Risk balanced by growth (Patton, 1959)	Cyclicality, demand impacted by seasons and economy (Staudt et al., 1976)	Risk of newer technologies (Sabol et al., 2013)

The table above gives a detailed look into the R&D, strategy, competition, and risk aspects during the four phases of the industrial life-cycle. Having a detailed understanding of how each phase brings out changes in organizational functions can help firms better develop their strategies to survive (Porter, 1980). McGahan (2000) states:

> *"Firms can improve their performance by tailoring investments to ride industry trends rather than to fight them"*

Improved corporate performance revolves around understanding the industry trends and using them to the firm's advantage. Having an overview of the life-cycle and general patterns that are exhibited by industries can be a useful tool for industries seeking to expand into a new market. Sabol et al. (2013) states that finding the right industrial context for the life-cycle and identifying an advantageous competitive position becomes a strategic goal for organizations to ensure survival. This also applies to a company which may be interested in entering the market, using the information available regarding the industry life-cycle and its current position in the market. The next section takes a look into factors that drive industry evolution.

2.3 Driving Forces of Industry Evolution

All industries evolve due to the forces that create incentives or pressurize firms into change to remain financially viable, this is known as the evolution process of industries (Porter, 1980). Every industry begins with a basic initial structure; even though it may undergo vast changes as it evolves, this initial structure depends on the economic and technical characteristics of the specific industry like the size, skill level, and resources available for the early entrants (Porter, 1980).

The investment decisions made by existing firms and new entrants to the market have a huge impact on the evolutionary process of industries. The pressure or incentives resulting from the evolution causes firms to invest and try to maximize the advantages for their own firm (Porter, 1980). Many industries that are emerging can be hard to distinguish at first, and often appear as segments to already established industries (McGahan, 2004). Porter (1980) states that even though the initial structure, potential, and investments are specific to different industries, few aspects of that occur in all industries can be generalized regarding the evolutionary process:

- Long run changes in growth
- Changes in buyer segments served
- Buyers learning
- Diffusion of proprietary knowledge
- Accumulation of experience
- Expansion in scale
- Changes in input and currency costs
- Product innovation
- Process innovation
- Structural changes in adjacent industries
- Government policy change
- Entries and exits

First, the biggest of the forces that leads to evolution is a change in long run growth. It is a very important variable in judging elements like competition, expansion, and market share. The five factors leading to change in long run growth identified by Porter (1980) are shown in the figure below.

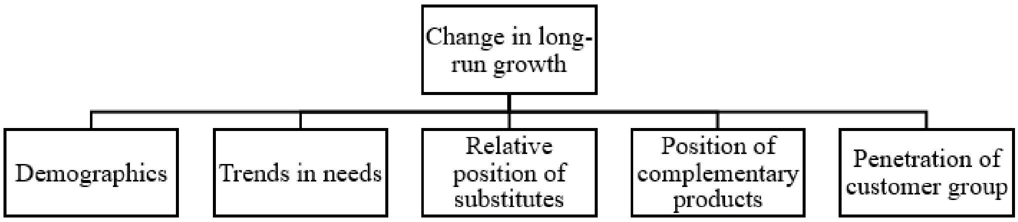

Figure 8. Factors impacting long-run growth.

Demographic variables can be things like household income, age, gender, and level of education. Changes in these variables can lead directly to changes in demand, like an increase in income can lead to increased demand. Demand may be impacted by trends like a change in taste, way of living, and a change in the way of thinking. The demand of a product or service can be impacted by the cost and quality of products that could act as replacements, like an increase in television advertisement over the years as a replacement for print advertisement. A change in the position of complementary products can also impact the demand for associated products. Industry growth also results from increased market penetration, which means selling to new customers in the same segment. Once full penetration is achieved, the focus shifts towards increasing sales to repeat buyers by trying to increase the per person consumption or replacement.

Second, a change in the buyer segments being served by the industry is an important evolutionary process. A good example of this is the light weight aircrafts, initially they were focused towards the military use and later the buy segments were expanded and commercial plus private users were added. Other changes can include serving the same segment with different products and it may be that a segment may no longer be served at all. The importance of understanding new buyer segments lies in the fact that serving these new segments can have a large impact on the industry structure (Porter, 1980).

Third, learning by those who are the consumers of the product or service plays a big role in industry evolution. Repeat purchasing allows the buyers to gain more and more knowledge of the product and its competition. This leads to a reduction in product differentiation in an industry and can cause buyers to claim more warranty protection or demanding improved product performance (Porter, 1980).

Fourth, with time, the technologies for products and their manufacturing processes become known to competitors (Porter, 1980). Diffusion can occur through a variety of ways as shown in the figure below.

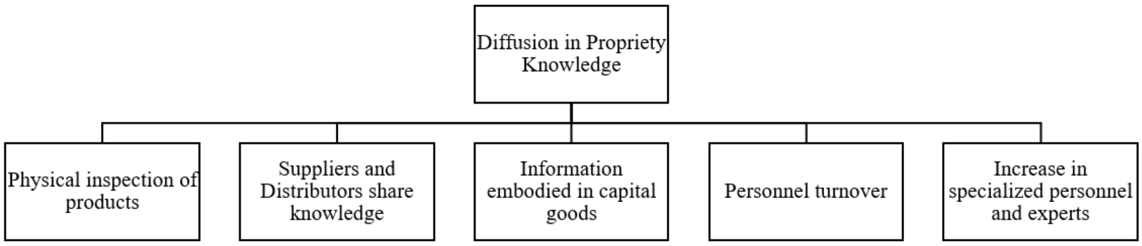

Figure 9. Factors causing diffusion of propriety knowledge.

In the figure above, we can see that diffusion of propriety of knowledge can occur through various ways. As products become readily available in the market, it is easy for competitors to physically inspect and reproduce similar items. Suppliers and distributors act as a big source of knowledge as they reap large benefits from diffusion of knowledge like creating another large supplier for their business. Many firms use outside suppliers for their capital goods, these suppliers acquire information that is then available to others that may be looking for it. Human resource is a very big factor in diffusion of knowledge, as people look for new opportunities in different companies, they take their knowledge and expertise with them to the new organization. Lastly, with time there is an overall increase in the number of experts regarding the products. In the absence of patent protection, diffusion of propriety knowledge speeds up and the advantage reduces at a fast pace.

Fifth, in some industries the unit costs start to go down as the human resource starts to gain more knowledge with time regarding activities like manufacturing, marketing and distribution. This is referred to as the learning curve, the figure below illustrates the learning curve in the manufacturing division of an organization.

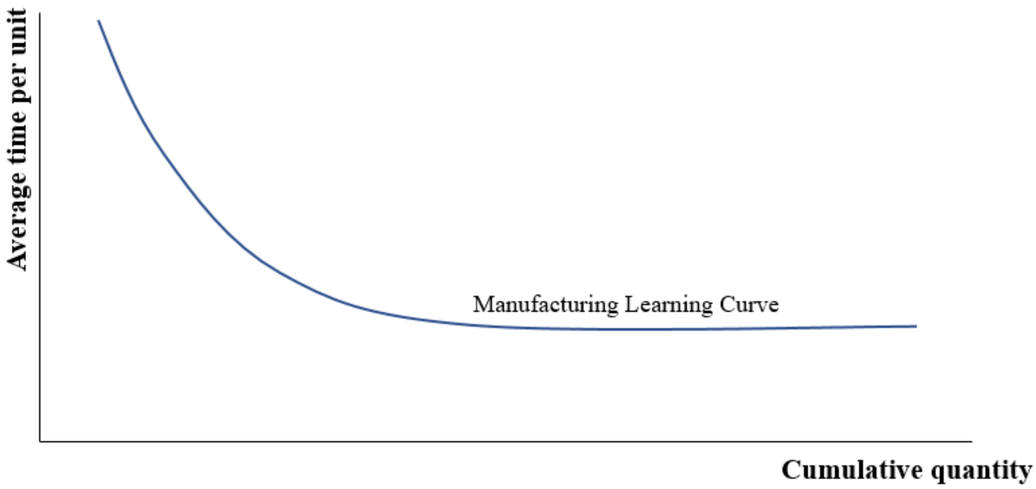

Figure 10. The learning curve in manufacturing.

It can be seen in the figure above that, with every unit produced, the manufacturing team reduced the average time needed to produce the unit. In the beginning the advantage is large, as significant learning occurs and the process is optimized by the human resource till it reaches a point where it stagnates. When this experience can be kept propriety, it can yield great competitive advantage and other industries must prepare strategies to improve their learning or acquire experience from elsewhere. Firms that are lagging have to strategize for imitation of the market leaders or focus on trying to gain advantage in other areas of business.

Sixth, an expansion or contraction in the scale of business. Usually, an expansion in scale means the companies which lead are undergoing expansion in absolute size, and the firms which are increasing their market share are witnessing even more growth (Porter, 1980). Expansion of scale is important in terms of industry structure as it helps increasing the business strategies that are available to generate advantage. Firms that have a large consumer base and keep growing can choose to invest in automation and trade the labor for capital and aim for economies of scale. Vertical integration also becomes a feasible option. An increase in the scale of business leads to an increase in the bargaining power of suppliers and distributors. Another threat is that a large industry scale can attract new entrants, especially large, established firms with the capabilities to challenge market leaders.

Seventh, changes in input costs for functions like manufacturing, distribution and marketing can lead to a change in industry structure. Some important input costs that may change mentioned by Porter (1980) are wages, raw material, capital costs, communication costs, and transportation costs. This may directly impact the price of the product which can lead to an increase or decrease in demand.

Eighth, a major change in industrial structure can result from technological innovations. Product innovation can make the market larger and drive growth and product differentiation. A big change in products through innovation can reduce buyer experience and shift the advantage towards the organization. Product innovations can come from inside the industry or externally; often ideas are generated by customers and suppliers and then move vertically leading to innovations (Porter, 1980).

Ninth, process innovation can lead to a change in industry structure as well. Innovations in the manufacturing processes can lead to greater economies of scale, reduced need for labor, make manufacturing more capital intensive, change the proportions of fixed costs, and increase or decrease vertical integration (Porter, 1980). Once again, these innovations can come from outside or from inside the industry itself.

Tenth, a structural change in the suppliers or customers can impact on the industry evolution since it directly affects their bargaining power (Porter, 1980). Since adjacent industries can have a direct impact on a firm, it is important to strategize for evolution in the industries that supply and buy from the company.

Eleventh, government policies can have a sizeable and direct impact on the industry evolution. Key variables are entry into the market, profitability, and market competition. Government policies can also have an indirect impact on the industry from regulations regarding safety standards of product quality, environmental aspects, and tariffs (Porter, 1980).

Twelfth, new entrants and exits from firms in the existing market can impact other industries and their operations. Entry from large, well-established firms can often be a big factor resulting in structural change. Entry is often motivated by growth potential and profits, though it can often be a poor indicator for a viable investment (Porter, 1980). Exits can also have a similar impact on the market as it reduces the number of competing firms and can possible lead to increase dominance of the ones that are already in lead. Firms exit a market when they no longer see a favorable return on their investment.

3. TECHNOLOGY EVOLUTION

3.1 The technology life cycle

Taylor & Taylor (2012) argue that the literature regarding the technology life cycle is overlapped and confused with the product life cycle and the industry life cycle. In the last chapter, it was highlighted that technology evolution can occur in the form of process or product innovation, both of which are drivers of industry evolution (Porter, 1980). There are two primary frameworks discussed in literature regarding technology evolution (Taylor & Taylor, 2012) which are:

- The Macro View
- The S-Curve

First, the macro view is a cyclical model with four stages that a technology goes through till another breakthrough technology takes its place. The technology evolution model introduced by Anderson & Tushman (1990) plays a central role in the technology life cycle literature. The stages in the technology life cycle are illustrated in the figure below.

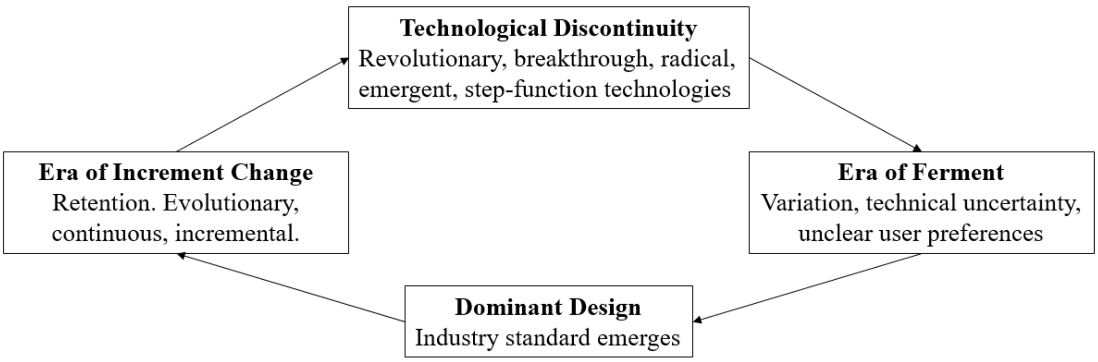

Figure 11. Stages of the macro technology life cycle (Adapted from Anderson & Tushman, 1990).

The cyclical model of the technology life cycle gives a macro view of the four stages: technological discontinuity, era of ferment, emergence of a dominant design, and an era of incremental change till a new technology emerges (Kaplan & Tripsas, 2008). The model caters of each individual technology life starting with a technological discontinuity which is a breakthrough in nature. These technologies can be defined as revolutionary or radical in nature (Yu & Hang, 2009). The introduction of such a technology causes a period of ferment to follow where a competition based on the variations developed regarding the initial technology takes place (Abernathy & Utterback, 1978). Eventually, a dominant design emerges in the industry from the different variations competing during the ferment stage (McGahan et al., 2004). This dominant design becomes the industry standard, which causes it to be adopted by a majority of the industry (Murmann & Frenken, 2006). Once the dominant design is adopted as the industry standard, an era of incremental change follows. There are evolutionary and incremental change in the dominant design during this era until a new technological discontinuity occurs (Yu & Hang, 2009). This causes the cycle to restart with the new revolutionary technology and go through the four stages described above.

Innovation in processes and products both play an important part in industry evolution (McGahan et al., 2004). Taylor & Taylor (2012) state that the macro model applies to both product and process innovation but the emphasis on either of them varies through the cycle. The figure below shows how the product and process innovation change during a life cycle.

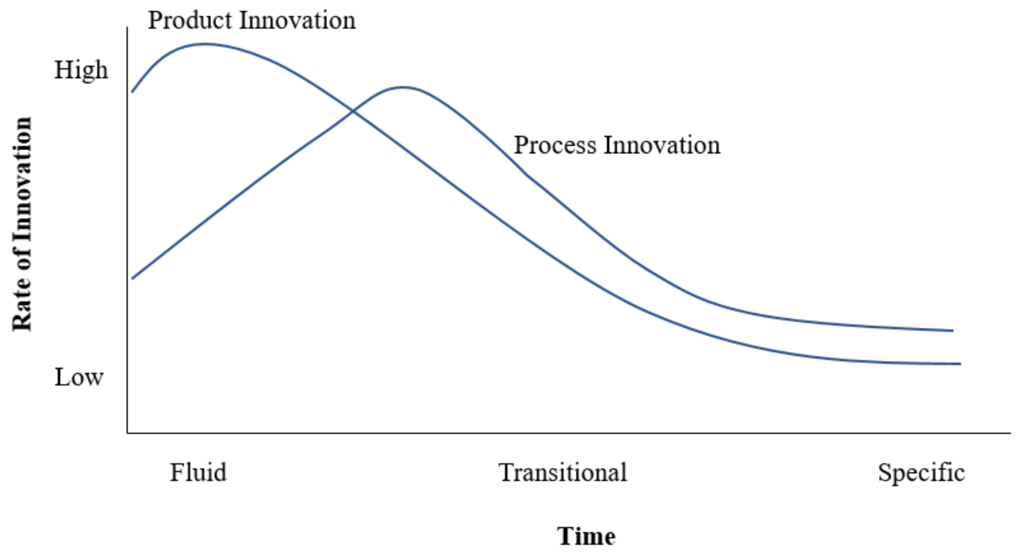

Figure 12. Product and process innovation in a life cycle (Adapted from Taylor & Taylor, 2012).

The basis of the model lies in the argument presented by Adner & Levinthal (2001) who state that consumer demand in the early stages is for a technology to meet a minimum criterion causing an emphasis on product innovation after which price becomes the focus leading to process innovation. The figure shows the rate of innovation plotted against time which illustrates that product innovation is high in the beginning of the cycle and starts go down as the cycle progresses and the process innovation goes up. At the end both go down as the technology matures and the opportunity for innovation in both products and processes reduces, hence making it a good time for another emerging technology to replace it (Adner et al., 2004). The fluid phase marks the competition between firms to innovate the product until a dominant design emerges, hence corresponding to the era of ferment (Taylor & Taylor, 2012). Once the dominant design emerges, there is an increased focus on process innovation for large scale efficient production and optimization.

The decreased flexibility in processes results in a further reduction in product innovation due to increased restrictions (Utterback, 1994). At the end both go down as the technology reaches its potential which gives rise to new potential technologies to start the cycle over again (Taylor & Taylor, 2012).

The technology S-curve is commonly based on the cumulative adoption of technology over time (Nieto et al., 1998). Foster (1986) states that technology adoption progresses slowly in the beginning and then rapidly before it eventually starts to decline which gives it the shape of an S-curve. The figure below shows the technology S-curve.

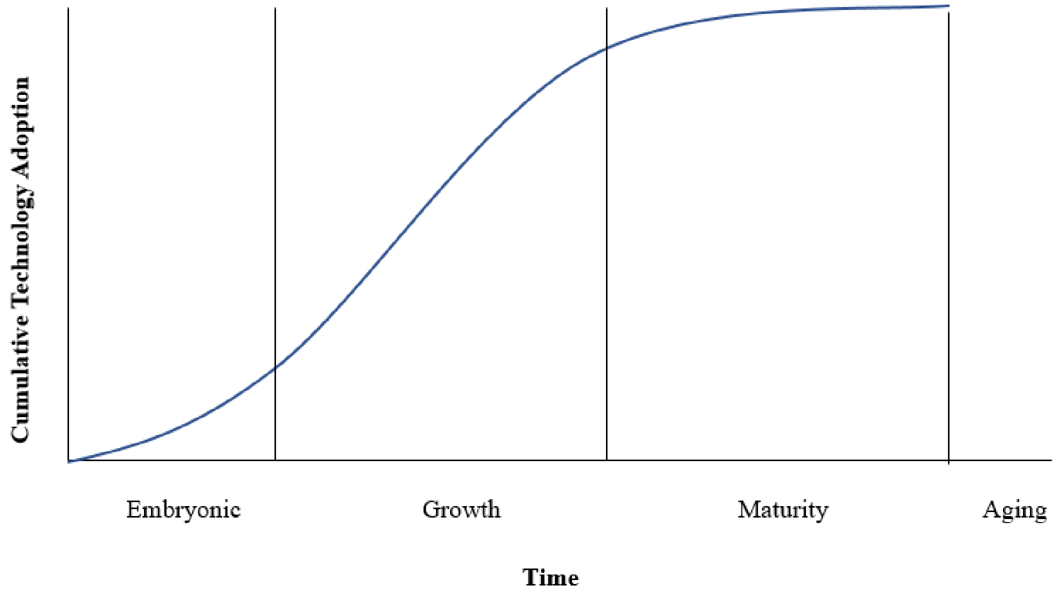

Figure 13. The technology S-curve (Adapted from Cetindamar et al., 2010).

The figure above shows the technology S-curve and the four stages it goes through, starting with embryonic and then moving on to growth and maturity and finally reaching the aging stage (Cetindamar et al., 2010). The curve shows that technology adopting starts off slow and then accelerates before the final stage where it declines, which supports the argument presented by Foster (1986).

Other authors like Dosi (1982), Sahal (1985) and Lu & Marjot (2008) use the performance of technology and its improvement against time to plot the S-curve. The result is the similar S-shape as the cumulative adopters of technology against time graph. This curve is based on technology performance being low in the beginning and then getting better as hurdles in the industry regarding the technology are overcome before finally the performance improvement slows down due to the technology reaching its limit. Taylor & Taylor (2012) highlight that empirical evidence has shown that the use of technology performance as the y-axis for the technology S-curve is not very accurate, as technology evolution tends to be closer to a step function, with improvements in technology performance that happen after a notable period (Sood & Tellis, 2005).

The technology S-curve also has other variants where the x-axis uses money put into technology development (Foster 1986) or the engineering effort (Christensen, 1992; Chang & Baek, 2010; Neito et al., 1998) instead of time. The table below shows the x-axis and y-axis for developing the technology S-curve in scientific literature.

Table 11. Summary of X and Y axis for S-Curve in scientific literature.

Author	Y-Axis				X-Axis		
	Cumulative adopting of technology	Technology performance	Evolution of patent applications	Willingness of customers to pay for technology performance	Time	Funds put into development	Engineering effort expenditure
Neito et al. (1998)	x				x		x
Foster (1986)	x	x			x	x	
Dosi (1982)		x			x		
Sahal (1985)		x			x		
Lu & Marjot (2008)	x	x			x		
Chang & Baek (2010)		x			x		x
Andersen (1999)			x		x		
Adner et al. (2004)				x	x		

The table above summarizes the views of different authors on the X and Y axis to develop the technology evolution S-curve. Taylor and Taylor (2012) point out that no matter the plotting and use of the X and Y axis variables, eventually the technology reaches a point of maturity which leads to a new disruptive technology to appear, causing a second cycle to begin all over again (Cetindamar et al., 2010). Chang & Baek (2010) state that once the performance of a starts to reach its limit, a new technology is introduced which may initially have lower performance but has higher potential. The figure below shows the idea graphically.

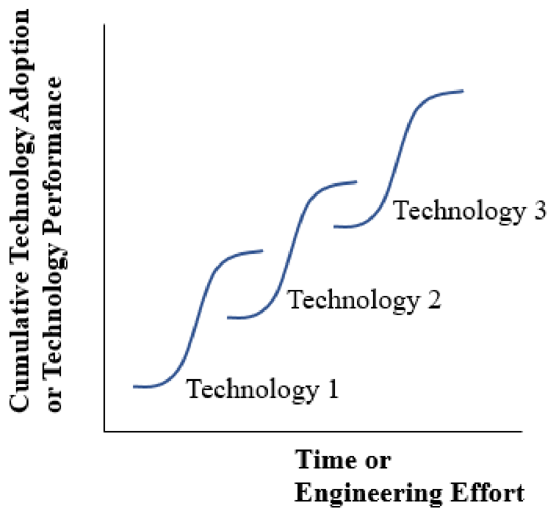

Figure 14. Technology evolution and disruptive technologies.

The figure above is a graphical representation of the idea that as one technology starts to reach maturity, a new technology is introduced which will eventually replace the old one. Initially the new technology may have a lower performance than the old one, but with time, it surpasses and replaces it due to its higher potential and overall performance (Chang & Baek, 2010). Most firms are advised to adopt the new technology timely to gain the advantages of improved performance and to stay competitive (Foster, 1986).

3.2 Technology Adoption

Many authors utilize the cumulative adoption of technology to develop the S-curve of technology evolution. This is based on the idea that not everyone adopts new technologies at the same period of time. Rogers (1983) states:

> “*Not all individuals in a social system adopt an innovation at the same time. Rather, they adopt in a time sequence, and they may be classified into adopter categories on the basis of when they first begin using a new idea*”

The development of adopter categories is advantageous because it allows firms to develop individual strategies based on their potential clients (Rogers, 1983). The cumulative adoption of technology is often plotted against time on the X-axis, as shown in the previous section. This is called the “S-curve of Adoption and Normality” (Rogers, 1983). The figure below shows the cumulative S-curve and the bell-shaped frequency curve.

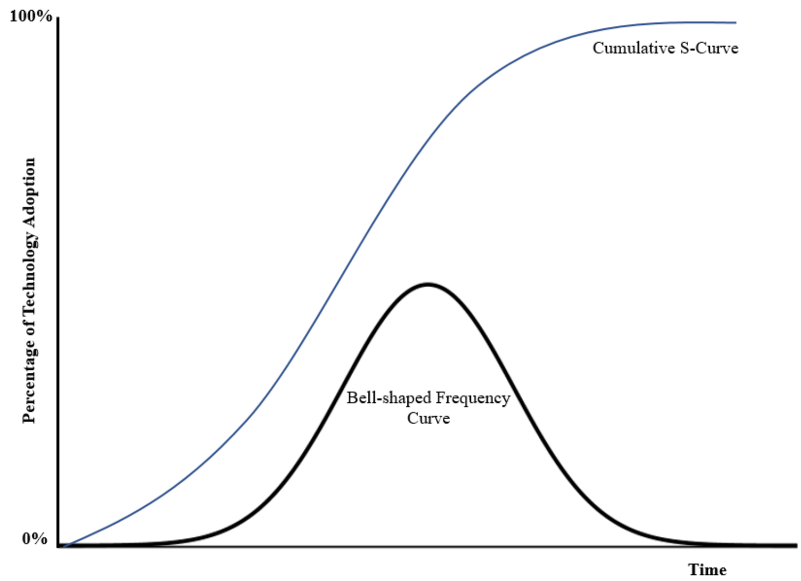

Figure 15. Technology adoption curves.

The figure above shows the two curves of technology adoption. The bell-shaped curve shows the data in terms of the firms or people that adopt the technology per unit time, while the S curve represents the same data in a cumulative form. Vitale et al. (2011) emphasize the importance of dividing the bell-shaped frequency curve into categories for market segmentation and positioning the firms offering based on the technology adoption life-cycle. This idea is built on the observations made by Moore (1995) that markets for innovations develop in a regular pattern.

Rogers (1983) states that before adopters are categorized, it is important to define the characteristics that each adopter category should abide by. These characteristics are that the categories should include all units in the study, the categories should be mutually exclusive and should be derived from the same principle of classification. Since the adopter distribution model approaches a normal distribution, several parameters of normality can be used to classify adopters of technology. The mean and standard distribution can be utilized as effective tools to divide the overall technology adopters in five separate groups (Rogers, 1983).

The titles assigned to the adopter categories have had numerous names in diffusion research literature even though the division of the categories based on mean and standard deviation has been widely done the same way (Rogers, 1983). The most innovative individuals have had titles of “experimentals”, “advance scouts”, “progressists”, and “ultra-adopters” assigned to them (Rogers, 1983). Vitale et al. (2011) gives the five categories the titles “technophiles”, “visionaries”, “pragmatists”, “conservatives”, and “laggards”. Hence it is important to clarify that despite different category names used in literature the basic principles for developing the categories remain the same, which is the division based on mean and the standard deviation. For the purpose of this thesis, the adopter category titles given by Rogers (1983) will be used. The five categories are:

- Innovators
- Early adapters
- Early majority
- Late majority
- Laggards

First, the innovators are the first 2.5 percent to adopt the technology. This percentage is calculated based on two standard deviations from the mean time of technology adoption. Second, the early adopters are 13.5 percent of the total adopters. They lie between the first and second standard deviation before the mean value. Third, the early majority are 34 percent and lie between the mean and the first standard deviation before the mean value. Fourth, the late majority are also 34% of the total adopters but lie between the mean value and the first standard deviation after the mean value. Fifth, the laggards are the last 16% to adopt the technology. The figure below shows the technology adopter categories, adopter percentages, mean and standard deviation as part of the bell curve of technology adopters.

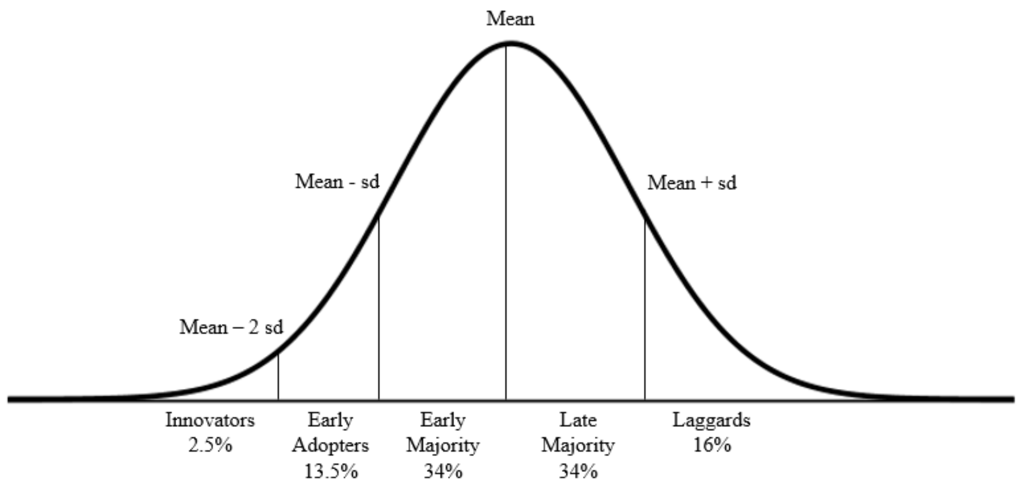

Figure 16. Technology adopter categories.

The figure above shows the five adopter categories, and the sum of all these categories yields 100% of the adopters. Rogers (1983) highlights that these categories are classified as ideal and this framework serves the purpose of allowing researchers to synthesize their findings. Empirical findings regarding each category helps develop generalizations about them hence developing an excellent resource for formulating strategies regarding marketing and sales.

It has been noted that with the first category, the innovators, venturesome is extremely high (Rogers, 1983). This means that they are very eager and accepting of new ideas and technologies. One notable characteristic is that they tend to have networks beyond geographical boundaries and communicate regarding technologies despite large distances. They play a very important role in helping to get the technology off the ground and starting the process of gaining acceptance in the industry (Brassington, 2007). It is common for them to buy early and are willing to take the risk and uncertainty attached to investing in an innovation. They play the role of a gatekeeper when introducing a new technology into the industry (Rogers, 1983). They often have the financial resources to absorb possible losses if the investment in the innovation does not pay off and have considerable technical knowledge to apply the technology to reap its benefits.

The second category, the early adopters, are a more integrated part of the local social system than the innovators (Rogers, 1983). They carry a high level of opinion leadership in the local social system and industry, and many potential adopters turn to them for their advice regarding the benefits and usage of the innovation at hand. They are critical for making an innovation generally acceptable, hence it is paramount to win them over as their word of mouth carries a lot of weight among potential adopters of the technology (Brassington, 2007). The early adopters serve as a role model for those to follow and often act as the basis for reducing uncertainty regarding the adoption of a new technology and the investment that may be associated with it (Rogers, 1983).

The third category, the early majority, constitute 34% of the adopters. They adopt the new technology before the average time in the local industry (Rogers, 1983). The hold an important position in the diffusion of the technology as they are an integral part of connecting those who adopt the technology very early and the late adopters. The early majority is more likely to wait and see response of the early adopters before investing (Brassington, 2007). If a product or technology does not reach the early majority, it can be a possible concern for the company that has developed it because they represent a sizeable portion of the total adopters and are also the link to the late majority in the technology life cycle.

The fourth category, the late majority, is also 34% of the total adopters like the early majority. The late majority is usually less bothered about the new technology or are willing to wait and see how the market develops before investing (Brassington, 2007). They adopt the new ideas after the average number of constituents of the local industry and are often moved into acquiring the new technology due to economic necessity or as an answer to increasing network pressure (Rogers, 1983). They tend to be cautious and skeptical about new innovations. They will often require little to no uncertainty before adopting the new technology. At this point the technology life cycle is also reaching the stage of maturity and hence there may be alternative products to choose from (Brassington, 2007).

The last remaining category is the laggards. Most laggard firms make decisions based on what has been done in the past and possess traditional values (Rogers, 1983). As the technology life cycle is in its final stages, it is quite possible that another newer innovation has already been introduced. They can be very averse to change and hence lag behind others in technology adoption (Brassington, 2007).

3.3 Factors that influence technology adoption

Asare et al. (2016) state that while technology has been a topic of frequent discussion in adoption regarding individuals, it has received little focus in terms of supply-chain or inter-firm adoption. A major part of technology adoption studies focuses on individuals leaving out a very important area which is the adoption of technology in organizations. (Rogers, 2003).

Asare et al. (2016) propose a framework that identifies elements that impact technology adoption in firms after studying previous literature on the topic. The framework identifies four keys areas that influence the adoption of technology in organizations which can be seen in the figure below.

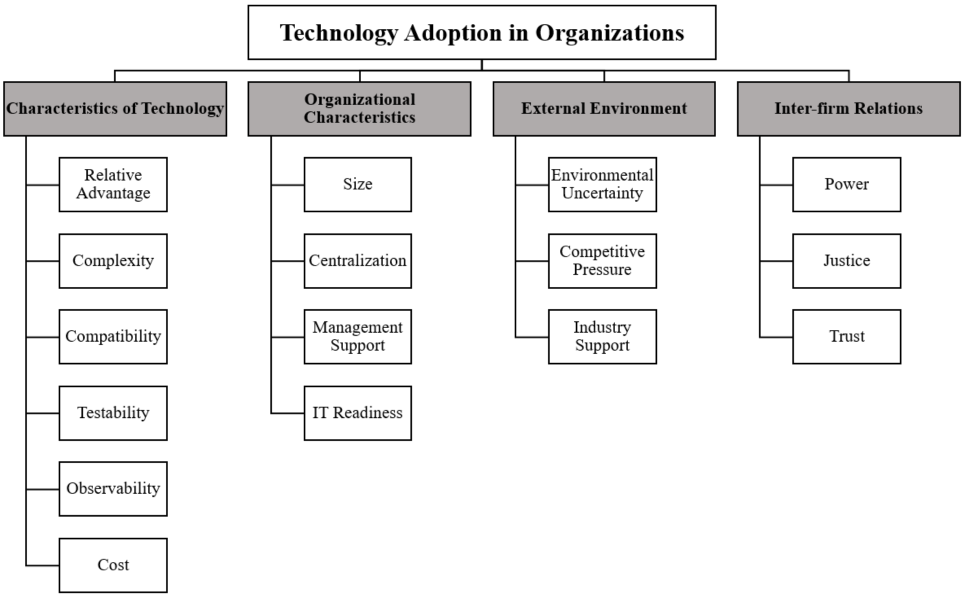

Figure 17. Factors that impact technology adoption in firms (Adapted from Asare et al., 2016).

The figure above shows the key factors that Asare et al. (2016) identified in technology adoption in B2B firms. The first category is characteristics of the technology. Relative advantage is widely used in technology adoption literature in inter-firm research and is one of the strongest predictors of adoption rate (Russel & Hoag, 2004). It is defined as the perception of how better the replacing innovation is in comparison to the one being replaced (O'Callaghan et al., 1992). Firms are more likely to adopt a technology they perceive to improve performance.

Complexity is defined in literature as three different dimensions, the complexity to understand, to use, and to implement (Asare et al., 2016). Highly complex technologies can act as a barrier to adoption of technology (Lin & Ho, 2009). Compatibility is determined by how easily the new technology can be integrated with the firms existing systems (Rogers, 2003).

Compatibility also has two dimensions: compatibility to the organization's current software, hardware, computers, and systems (Lin & Ho, 2009), and compatibility to the organization's internal culture (O'Callaghan et al., 1992). Both factors can significantly influence a firm's ability to acquire a technology.

Testability or trialability is the extent to which a technology can be experienced before the firm decides to adopt it (Rogers, 2003). Being able to have trials enables firms to analyze the innovation and learn to use it, thus reducing the complexity (Al-Gahatani, 2003).

Observability is defined as the ability to demonstrate the results and benefits of the innovation (Al-Gahatani, 2003). Moore & Benbasat (1991) define it as the visibility of the technological innovation itself. The first definition is more accurate in inter firm technology adoption; if the innovation can be tied to improving sales, profits, and return on investments, it becomes more likely to be adopted (Asare et al., 2016).

The cost of innovation is one of the key variables which influence a firm's decision to adopt a technology. Asare et al. (2016) define two main components of cost of innovation; the direct costs are the costs of acquiring the product itself while the indirect costs are the costs associated with using, implementing, and maintaining the technology.

The next category is organizational characteristics. Management support refers to the level to which the senior managers in the organization support the innovation. Management support can be a very important variable in inter firm technology adoption as they can be expensive and complicated, which increases the need to have long term vision to acquire them (Premkumar & Ramamurthy, 1995).

Centralization refers to the level at which the decision-making authority is limited in an organization or firm (Kirca, et al., 2005). Usually, the lower level managers have a much higher possession of technical knowledge and understand operational issues better (Amami & Brimberg, 2004). Thus, they are able to better understand the benefits offered by a new technology. Organizations with decentralized structures have higher ability to adopt newer innovations (Kamaruddin & Udin, 2009).

Organizational size is one of the most commonly used measures to understand an organization's level of innovativeness (Asare et al., 2016). It has been both positively and negatively associated with adoption of technology. Usually larger organizations have more resources to invest in newer technologies, but due to lower flexibility, they are unable to undertake the adoption quickly (Damanpour, 1996). Rogers (2003) states that despite the reduced flexibility, organizational size and adoption of technologies hold a positive relationship based on empirical evidence.

IT readiness is associated with the level of sophistication of the IT management in an organization; companies with higher levels o of IT sophistication adopted newer technologies quicker (Asare et al., 2016). These firms are more likely to have the required expertise and knowledge in their organization to adopt, implement, and use the technology (Iacovou et al., 1995).

The third category is the external factors. Environmental uncertainty can make companies feel at risk of falling into economic crisis and become more vulnerable, hence making them more open to ideas of newer technologies that could help them perform better to develop a stronger footing (Grover & Goslar, 1993). Patterson et al. (2003) state that a good example is that industries tend to adopt IT technologies in uncertain environments to help make communication more effective with their trading partners.

Competitive pressure can be a key driver to acquisition of new technology. Companies are often pressured into adoption of newer technologies because of their trading partners or competitors (Chwelos et al., 2001). Premkumar & Ramamurthy (1995) state that many companies tend to rush into technology adoption once their competitors have acquired it, even if they may not require it.

Industry support refers to the support received from industrial associations, industry standards, and industry wide initiatives that promote technology adoption (Asare et al., 2016). Industrial associations that support technology adoption often use multiple means to encourage local organizations to be open to innovativeness. They help in the creation of standards, infrastructure, and training of members in the associations to use the new technology (Lin & Ho, 2009).

The last category is the inter-firm relationships. Power is defined as the ability of one firm to exert influence onto another firm (Frazier, 1983). This can play a crucial role in inter-firm technology adoption as usually the organization that creates the new technology pushes it to the firms that are their target customers (Asare et al., 2016). Firms can take a persuasive or coercive approach to use their power and make other firms adopt the new technology, but coercion can cause long-term damage to inter-firm relationships.

Justice is important in maintenance of quality of channel relationships (Gilliland & Manning, 2002). Perception of injustice or unfairness can lead to hostility. Quite frequently, the technology adoption process is started by the larger firm which then requests its trading partners to adopt the technology as well (Iacovou et al., 1995). Partner companies can often find this unfair as it might be that the new technology offers limited value to them. Suzuki & Williams (1998) state that often partner firms that are threatened into adoption of newer technologies may buy the innovation out of fear of losing contracts with their larger partners but might not implement it. This makes justice a very important factor in inter-firm technology adoption.

Trust is a very important part of doing business and is directly tied to inter-firm success (Morgan & Hunt, 1994). Trust provides a sense of security that is created through predictability (Andaleeb, 1996). Morgan & Hunt (1994) state that trust increases confidence in another party’s integrity and reliability. This can directly influence the technology adoption positively. Trust can be credibility, competence, and benevolence based, all three have a positive association with intention to adopt technologies (Asare et al., 2016).

4. CUSTOMER VALUE IN NEW TECHNOLOGIES

4.1 Customer value

Khalifa (2004) states that, in recent years, there has been a rise in utilizing customer value and value based selling techniques in the industry. Eggert (2002) states that there has been a resurgence of interest in customer value in the field of marketing as well: in the research paper, it is highlighted that there is a direct impact of perceived value on the purchasing managers. Customer value is central to generating competitive advantage and the success of a firm in the long term (Khalifa, 2004).

Navid (2015) compares the definition of customer value from different authors. Zeithaml (1988) defined customer value as:

> *"... customer's overall assessment of the utility of a product based on perceptions of what is received and what is given*".

This definition implies that customer value is an exchange: to gain a product and its benefits, the customer must give something in return. Navid (2015) highlights in his study that other authors like Anderson & Narus (1998), Gale (1994), Monroe (1990), and Day (1990) have defined customer value in a similar way. Woodruff (1997) defines customer value as:

> *"...a customer's perceived preference for and evaluation of those product attributes, attribute performances and consequences arising from use that facilitate (or block) achieving the customer's goals and purposes in use situations."*

This definition includes the value a customer desires from a product and the value that is received. It highlights that customer value is based on what the product helps in achieving when used. Khalifa (2004) states that, in literature, authors have acknowledged the difficulties in defining customer value. These difficulties arise from the fact that value is subjective and dynamic in nature, which causes it to change with time (Jaworski and Kohli, 1993; Naumann, 1995).

Despite the difficulties in defining customer value, authors are in agreement over customer value being a customer perception and not a supplier's intention (Khalifa, 2004). Value is not based on what a supplier adds to a product but on what the customer receives from the purchase. Khalifa (2004) states that customer value definitions fall in three general categories:

- Value component models
- Means-ends models

- Benefit/cost models

First, the value component models are based on three value elements which are esteem value, exchange value, and utility value (Kaufman, 1998). Esteem value represents the want, exchange value represents the worth, and the utility value is the need. Kaufman argues that each purchase is based on a combination of the three value components. Khalifa (2004) states that Kano's model of customer perception is well-known and accepted. It has three components of value, dissatisfiers, satisfiers, and delighters. The figure below shows the model.

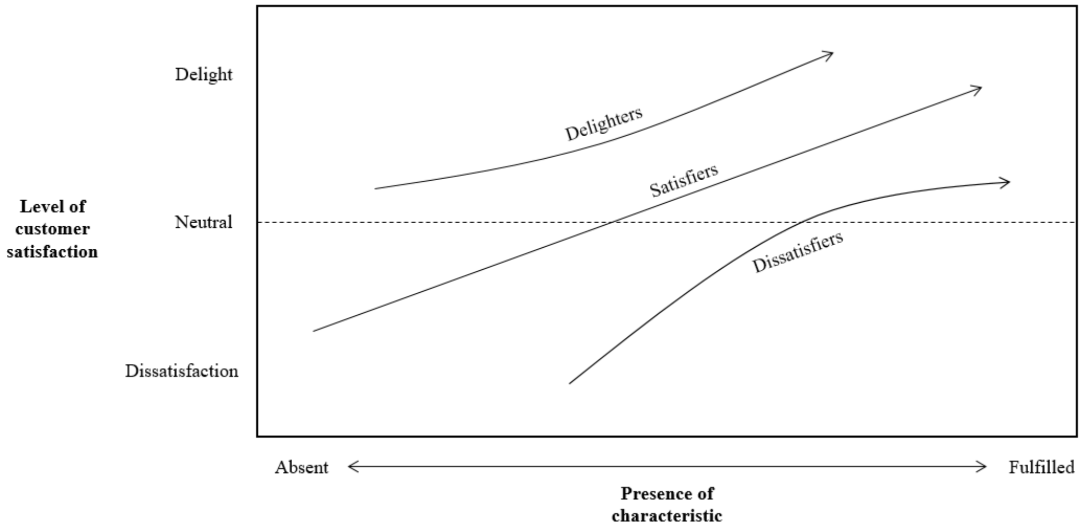

Figure 18. Kano's model of customer perception (Adapted from Khalifa, 2004).

In the figure above, the three elements can be seen: the delighters, satisfiers, and the dissatisfiers. The delighters are the features that a customer does not expect to be a part of the purchase, but their presence can be highly satisfying. Satisfiers are the features that are expected as a part of the purchase, and dissatisfiers are the characteristics that must be present in the product or service, otherwise the customer will be disappointed with the purchase. (Khalifa, 2004).

Second, the means-ends models define customer value based on the assumption that a purchase of products or services is done to accomplish favorable ends (Khalifa, 2004). This view is popular in consumer behavior literature where customer value is defined with the combination of mental images or cognitive representations underneath the customers' needs (Gutman, 1991). Means are the products and services being purchased, and the ends are the values that the customer deems important. Sheth et al. (1991) identified five key values which are functional, social, emotional, epistemic, and conditional. These five values can influence the purchase behavior of a customer.

Woodruff (1997) emphasizes on value stemming a customer's learnt perception, evaluations, and personal preferences. Woodruff's model can be seen in the figure below.

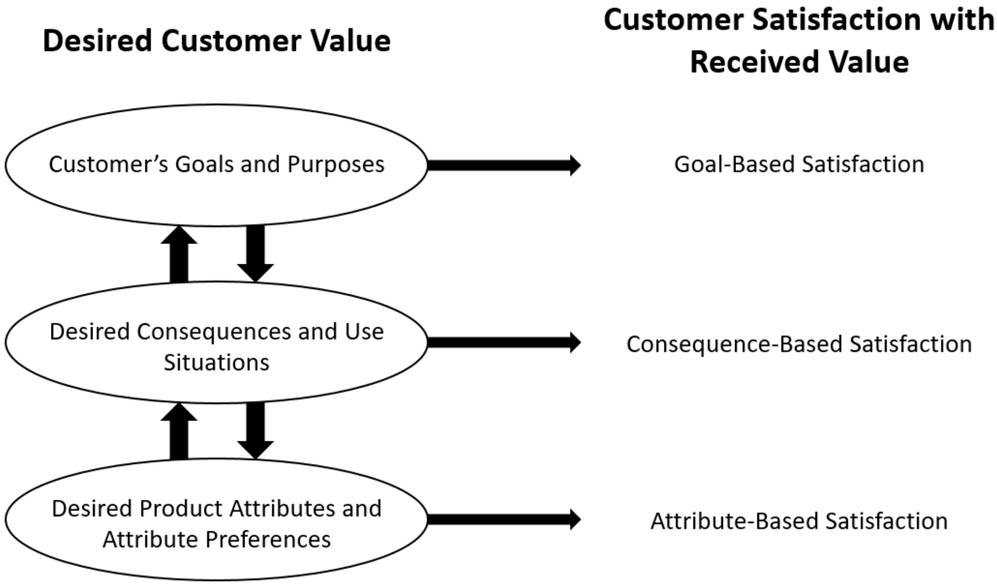

Figure 19. Woodruff's customer value hierarchy model (Adapted from Khalifa, 2004).

In the model shown above, while moving up in the hierarchy customers perceive products as bundles of attributes and their performances. They have preferences based on certain attributes and their ability give the desired results. Moving down the hierarchy, the customers give importance to consequences by using goals and purposes. Khalifa (2004) highlights that the means-ends model gives an explanation as to why consumers attach different weights when evaluating products and services.

Third, the benefits/costs models use value in relation to a customer's perception of the benefits that they receive from the purchase and the sacrifices they have to make (Leszinski & Marn, 1997). The use of benefits/costs models is commonly found in literature regarding strategic management (Khalifa, 2004). These models will be discussed in more detail in the following section.

4.2 Benefits/costs value model

Using the benefits/costs model has been a popular way to define customer value in literature (Khalifa, 2004). Gale (1994) states that benefits for the customers include both tangible and intangible characteristics of the product. The sacrifice includes monetary and non-monetary factors, including time and effort to buy and utilize the product (Kotler, 1996).

Navid (2015) compares the benefits/costs models from six authors; Anderson & Narus (1998), Lapierre (2000), Khalifa (2004), Menon et al. (2005), Smith & Colgate (2007), Lyly-Yrjänäinen et al. (2010). In his study, he finds many similarities among the six models he compares, but highlights that authors happen to use different terminologies for the same concepts. An adaptation of his comparative study is shown in the table below.

Table 12. Framework for value drivers (Adapted from Navid, 2015).

Customer Value	Benefits	• Functional • Economical • Service • Psychological • Social
	Sacrifices	• Purchase Price • Acquisition Cost • Operational Cost • Disposal Cost • Psychological Cost

The figure above shows the simplified version of the framework developed by Navid (2015) which shows the key value drivers identified in literature for the benefits/costs model. The benefits and sacrifices are both divided into five groups. Functional benefits are the advantage a customer gets from utilizing the purchased product (Sheth et al., 1991). Economic benefits are a result of the money paid and the value generated by the product in business. Service benefits consist of staff behavior and customer support. Psychological benefits are characteristics of the product like the ease of using it, availability, and accessibility (Smith & Colgate, 2007). Social benefits are the result of benefits a company received due to the product image (Sheth et al., 1991).

The first sacrifice element is the purchase price: it is the money that a customer pays to the supplier to acquire the product. Acquisition costs include other costs that come along with the purchase like ordering, logistics, and warehousing costs. Operation costs are the costs that the customer incurs in daily activities resulting from the usage of the product. (Navid, 2015) Disposal costs are a result of disposing off the product (Lyly-Yrjänäinen et al., 2010). The psychological costs include the mental stress, search, learning, and switching cost (Smith & Colgate, 2007).

Navid (2015) uses this framework of value drivers to develop a customer value model using the perceived customer value model by Lyly-Yrjänäinen et al. (2010). The reason for selecting this model over the others evaluated is the simplicity with which it illustrates the customer value concept (Navid, 2015). This model is shown in the figure below.

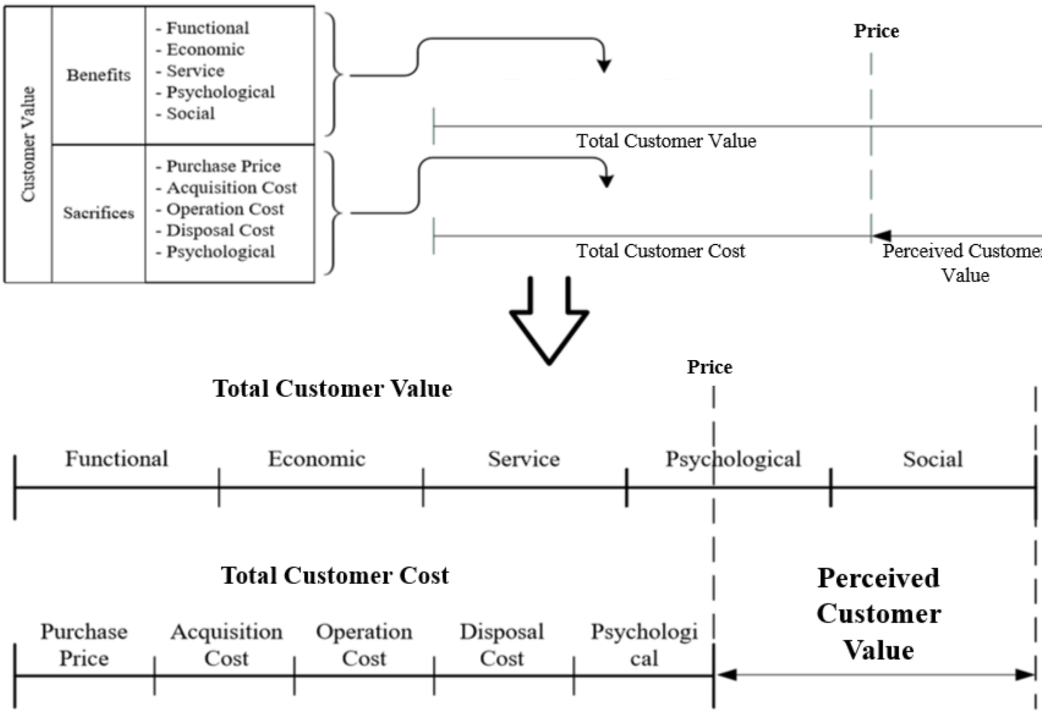

Figure 20. Customer value model (Adapted from Navid, 2015).

Navid (2015) highlights that, in the figure shown, the value drivers are divided equally but this is not the situation in real life scenarios. The weightage of each of these drivers vary significantly from one case to another from the perspective of the customer. This framework will play a fundamental part of developing a value proposition for new technologies in the next section.

4.3 Developing a Value Proposition for New Technologies

Showing customers the value a product/service has to offer to their company is extremely important. The value proposition method can be used as a tool for doing this (Camlek, 2010). Webster & Wind (1972) state that organizational buying behaviors eventually come down to individuals making the purchasing decisions, thus making it important for marketing professionals to account for both cognitive and affective elements. Eggert & Ulaga (2002) state that their research suggests that value must first be created by the supplier and then must be experienced by the customers organization.

Navid (2015) states that based on the definition of value proposition provided by Webster (1994), it is a communication tool for displaying the core competencies of the supplier's product and its offering to well-defined customer segments. Value proposition should be developed from a customer's perspective and should be specific, precise, and measurable (Barnes et al., 2009). Lanning (2000) highlights that it is important to communicate the value after developing it by activities like sales promotion, advertisements, and readily using the firms sales force. Barnes et al. (2009) created a value proposition model to construct value propositions successfully. The model consists of six steps and it is illustrated in the figure below.

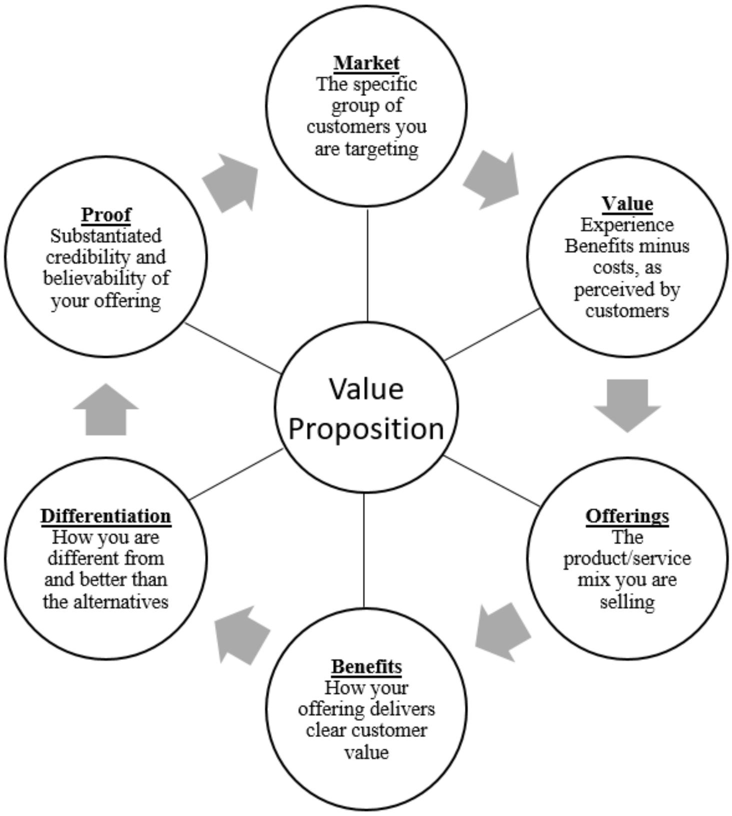

Figure 21. Model for building value proposition (Adapted from Barnes et al., 2009)

The first step in the model shown above is identifying market segments in which the company has the ability to offer profitability. The second step is identifying what customers see as value. Methodologies like interviews, surveys, and focus groups can help in drawing out the customers actual needs. The third step is presenting the company's product mix which is capable of providing the value. The fourth step involves calculating the value the supplier's product has to offer from the perspective of the company that is purchasing it. The fifth step is to evaluate the competitive and alternative options available to the customer to fulfill their needs; using the information collected, a superior value offering can be developed. The last step is to demonstrate the value offering with proof like case studies, testimonials and value calculations.

The goal of this section is to develop a value proposition for new technologies. The framework built by Navid (2015) based on the costs/benefits model introduced by Lyly-Yrjänäinen et al. (2010) shows a significant overlap with the framework developed by Asare et al. (2016) which identifies factors that impact technology adoption in firms. A side by side comparison of the two can be seen in the table below.

Table 13. Comparison of value drivers in value proposition and factors that impact technology adoption.

Value Drivers *Navid (2015)*	**Factors Impacting Technology Adoption** *Asare et al. (2016)*
Functional	Relative Advantage, Industry Support
Economical	Relative Advantage, Observability
Service	Relative Advantage, IT Readiness, Business Environment Uncertainty
Psychological	Trialability, Industry Support, Power, Justice, Trust
Social	Organization size, Management Support, Trust
Purchase Price	Cost
Acquisition	Cost
Operational Cost	Complexity, Compatibility, Cost,
Disposal Cost	Cost
Psychological Cost	Cost, Centralization, Competitive Pressure

The table above shows that the value drivers identified by Navid (2015) are conceptually the same as the factors that impact technology adoption in firms by Asare et al. (2016). It is worth noting that both authors breakdown the drivers into different categories. Asare et al. (2016) take a more detailed approach to identifying the factors except for the 'Cost', which is broken down into five different value drivers by Navid (2015). This finding shows that the value proposition framework is an excellent tool that can be used by suppliers for developing sales material regarding value offering to illustrate the benefits of the new technology they are introducing into the market. Henceforth, for this thesis, these identified elements will be referred to as value drivers.

Both Navid (2015) and Asare et al. (2016) agree that the value drivers can carry different weight depending on the customer. In the technology adoption literature, the five adopter categories have distinct characteristics based on extensive previous research (Rogers, 1983). The general characteristics regarding the adopter categories can provide information on what firm's value. This is based on where they lie in the technology adoption curve. Moore (1991) sees the early majority as a very different group from the early adopters. He sees selling an innovation to these two categories as significantly different as the there is a striking difference between their characteristics. However, it is extremely important to target both, as the transition from early adopters to early majority plays an essential role in the success of a new technology. The figure below shows the generalized character traits from early adopters and the early majority as adapted from Moore (1991) by Geoghegan (1994).

Table 14. Comparison of early adopters and early majority characteristics (Adapted from Moore, 1991).

Early Adopters	Early Majority
• Technology focused • Proponents of revolutionary change • Visionary users • Project oriented • Willing to take risks • Willing to experiment • Individually self-sufficient • Tend to communicate horizontally (focused across disciplines)	• Not technically focused • Proponents of evolutionary change • Pragmatic users • Process oriented • Averse to taking risks • Look for proven applications • May require support • Tend to communicate vertically (focused within a discipline)

The table above shows that there is a big difference on the way the early adopters and the early majority perceive new technology. Early adopters have more in common with the innovators, and the early majority share characteristics of the late majority. Hence, it is proposed that the value proposition that has to be developed for a new technology should be broken down into three distinct groups. The groups can be seen in the figure below.

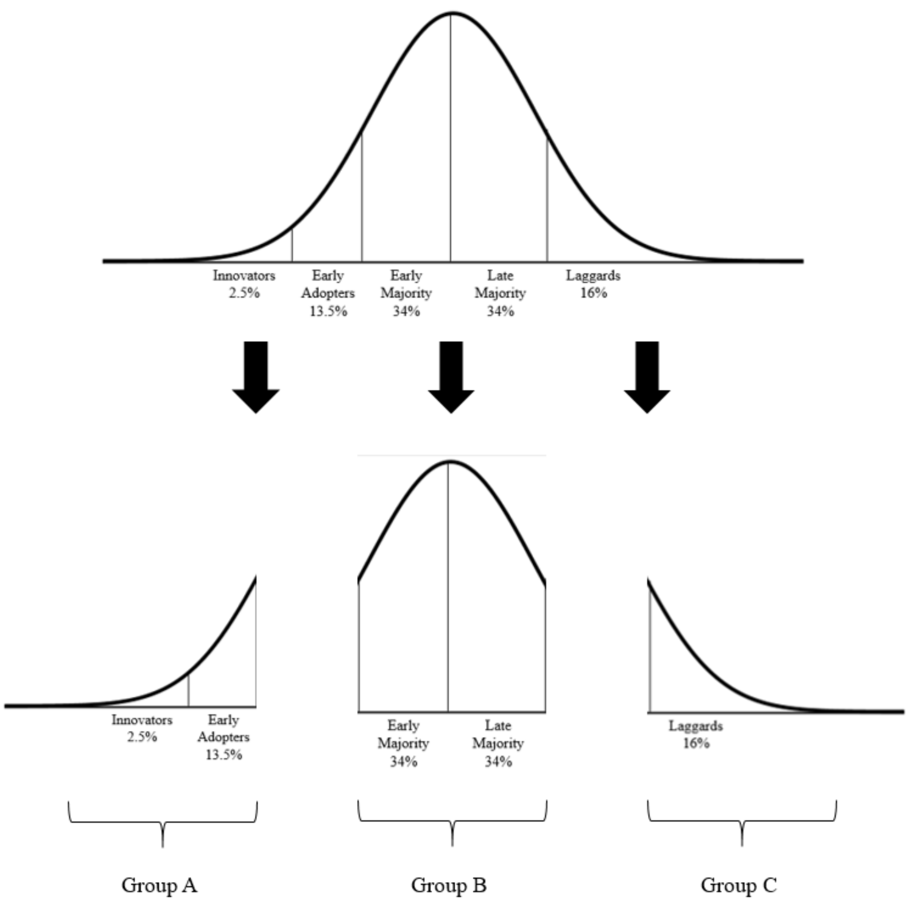

Figure 22. Breakdown of adopter categories in three groups.

The figure above shows the five adopter categories put into three groups. Group A comprises of the innovators and the early adopters. Group B is the early majority and the late majority, and Group C is the laggards. Targeting Group A with a tailored value proposition is important, as they are the first ones to adopt the technology and carry a significant weight when it comes to acting as a role-model for Group B to follow (Rogers, 1983).

Group B needs to have a separate value proposition developed for them as they do not share the same visionary approach as Group A and are more averse to risk. They usually look for proven applications before investing (Geoghegan. 1994). Targeting this group carries importance as they make up the majority of the adopters with a total of 68%. Group C comprises of laggards who have the tendency to be extremely technology averse; literature suggest that it may often be that a new technology has already entered the market when they may choose to adopt (Rogers, 1983).

5. TECHNOLOGY AND INDUSTRY EVOLUTION IN DEVELOPING COUNTRIES

5.1 Linking technology and industry evolution

In the product life cycle literature, the term 'product class' refers to a generic product, e.g. a motor car (Grantham, 1997). The product life cycle curve plots sales volume and uses time as the independent variable; it illustrates market demand for a certain product which functions using a specific technology, like a motor car using the automobile technology (Taylor & Taylor, 2012).

For many non-assembled and simple assembled products, technological progression is seen in the form of material and production process development (Tushman & Rosenkopf, 1992). An example of this is the glass manufacturing process which is impacted by emergence of three major technological breakthroughs: cylinder blowing, continuous drawing, and flat glass. While the final product and its final specifications may vary slightly due to different manufacturing processes, the product itself remains the same. Thus, the production technology undergoes multiple life-cycles, while the product life cycle and the industry life cycle do not (Taylor & Taylor, 2012). The figure below shows the technology life cycle as a part of the industry life cycle, hence linking technology and industry evolution.

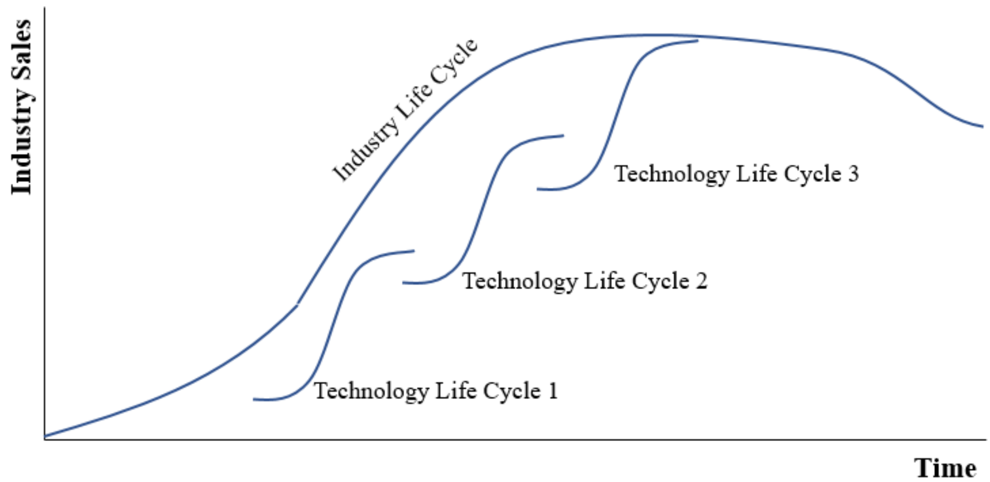

Figure 23. Technology life cycle as a part of the industry life cycle.

The figure above presents the idea of technology evolution being a part of the industry life cycle. Multiple technologies evolve and go through their life cycles for any given product. Most newer technologies have higher potential and overall performance, causing most industries in the market to switch to them as they may offer optimization of the production process and increased savings (Chang & Baek, 2010).

The framework developed above represents the industry and technology evolution of a simple product. Complex products involve multiple distinct sub-systems each of which have life-cycles of their own (Taylor & Taylor, 2012). An example of this is aircrafts which has sub-systems to handle propulsion, lifting, landing, and accommodating passengers (Tushman & Murmann 1998). Hence, considering the technological evolution in a parent product that comprises of many individual sub-systems and the mechanisms that link them together can be highly complex. Taylor & Taylor (2012) state that it is easier to evaluate technological evolution in complex products by tracking developments in individual sub-systems and using application, paradigm, and generations to model it. The figure below shows the framework developed by Taylor & Taylor (2012).

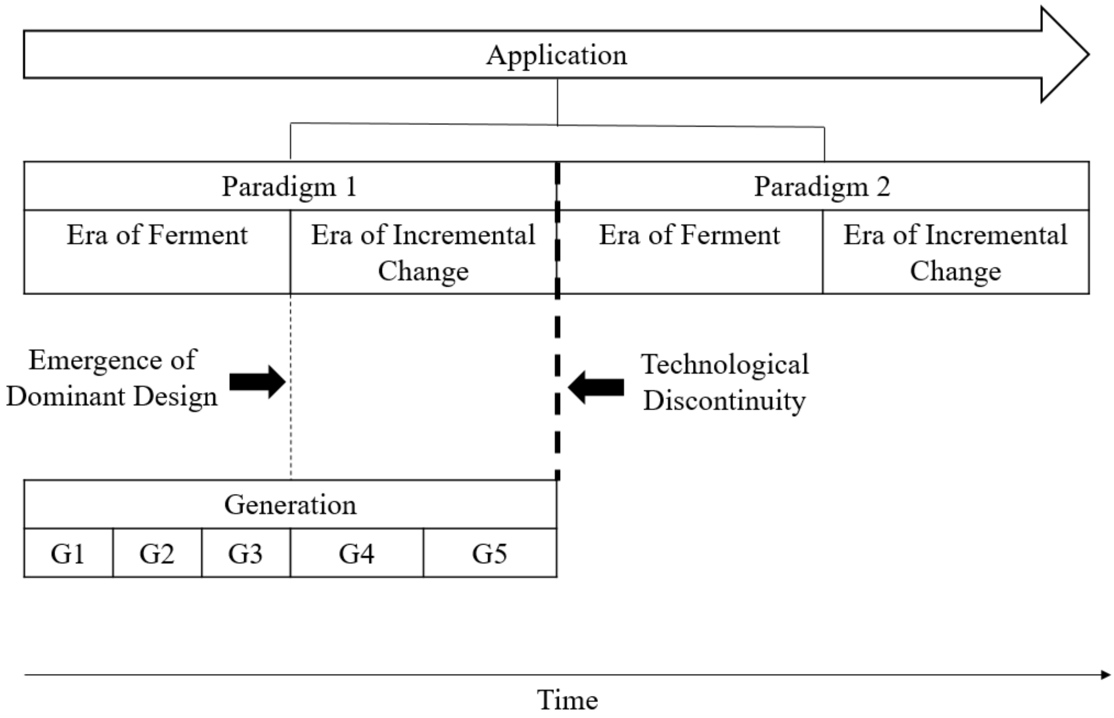

Figure 24. Technology life cycle as a part of the industry life cycle.

The figure above shows the emergence of technological paradigms over time for each individual sub-system's application in a complex product. Each paradigm represents a technology S-curve until a new disruptive technology emerges and eventually replaces it. It is important to note that even though the figure shows no overlap, there may be a period in which the old and new technology overlap and compete with each other, until the new technology surpasses the old one in terms of performance (Taylor & Taylor, 2012). For each paradigm there is an era of ferment where different designs of the same technology compete against each other till a dominant design emerges (Murmann & Frenken, 2006). This dominant design is then adopted by most of the industry. The generations represent small incremental changes to the technology designs. The framework offers an excellent way to track technological evolution in products and combines the Macro-view and the S-curve for the technology life cycle.

5.2 Developing a framework for technology and industry evolution in developing countries

Industry evolution has been popular in strategic management literature as it offers important insights on the different phases a market may go through. Similarly, technology evolution and adoption has been a topic of frequent discussion, focusing on reducing barriers to allow transition from one technology to another. However, literature seems to be lacking when it comes to discussing industry evolution models in developing countries. One of the major reasons is perhaps that industry and technology evolution models are generalized models that are applicable to all markets and industries. This would mean that the technology and industry evolution models remain the same when applied to developing countries. While this argument may be true there is one very important factor which differentiates the industry and technology evolution in developing and developed countries, which is that developing countries lag behind the developed countries in terms of technology and industry life cycles. This is also indicated by the names ‘developing’ which implies that these countries are still in the process of growing while the ‘developed’ have already reached stages of maturity or decline.

Developing a model for technology gap between developing and developed countries is easier because growth, competitiveness, technology diffusion, and technology gap have been studied by authors in literature regarding economic development. Fagerberg (1987) conducted a study of 25 industrial countries for the period of 1960 to 1983 and found that there was a close relationship between economic development and technology development. Technology is a key driving factor for economic growth and the changes in the growth rate of a country (Fagerberg & Verspagen, 2002). Fagerberg (1987) builds on Pavitt and Soete (1982) framework for international diffusion of technology where there is a distinction between the countries that develop new technologies and others that adopt the technologies later through diffusion of knowledge which leads to the technology gap. The figure below shows the proposed model for technology lag between the developed countries and the developing countries based on the arguments presented above.

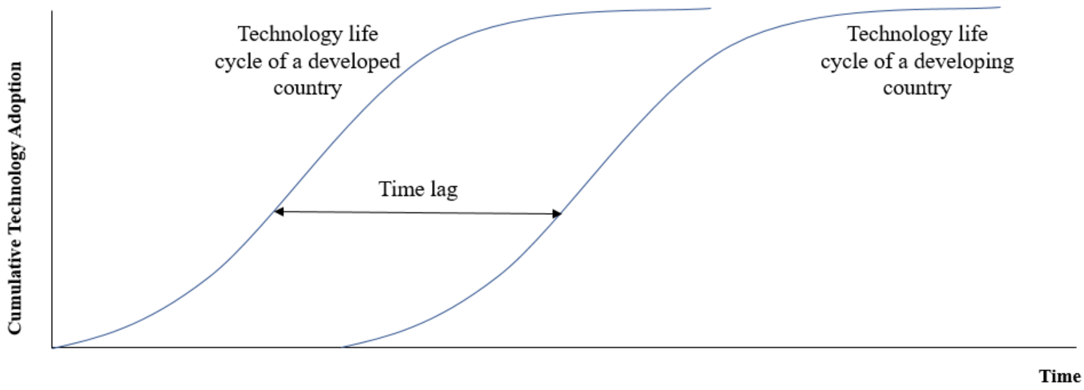

Figure 25. Proposed theoretical model of technology adoption lag between developing and developed countries.

The figure above shows the theoretical model of developing countries lagging behind in adoption of new technologies that are created in developed countries. However, it is important to note that it is possible for a country that lags behind technologically to catch up through imitation of technology (Fagerberg & Verspagen, 2002). Fagerberg et al. (2007) perform an empirical analysis of 90 countries based on four different aspects of competitiveness which are technology, capacity, demand, and price/cost. The results of the analysis showed deteriorating technology and capacity competitiveness, along with a bad export structure to be the biggest factors causing the developing countries to lag behind in technology.

Using the framework developed above a similar argument can be made for the industry evolution in developing and developed countries. As mentioned in the beginning of the chapter, the developing countries lag behind the developed ones in terms of the industry life cycle. While many developed countries may be at the stages of maturity or decline in certain industrial segments, the developing countries may be in the early stages of introduction or growth. Following the concept illustrated earlier, the framework for developing countries lagging behind developed countries is shown in the figure below.

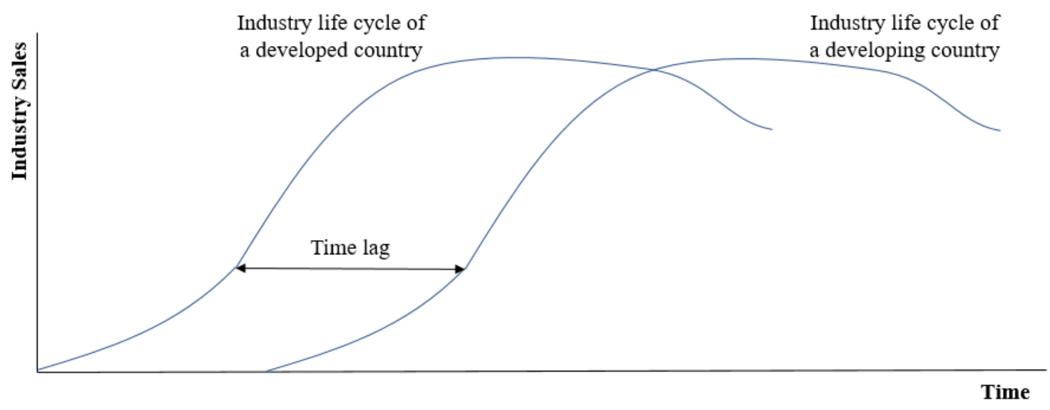

Figure 26. Framework for developing countries lagging behind developed ones in the industry life cycle.

In the figure above, it can be seen that while the developed countries may be in the final stages of maturity or decline in their industry life cycle, the developing countries may have just started their growth phase. Analyzing the current industry level in a developing country can give a company excellent insight into strategic opportunities regarding investment and expansion to a new market segment where there could be a lot of business potential due to fast growth.

The technology and industry life cycle lag between developed and developing countries is a good way for companies in developed countries to understand the technology level in countries that lag behind. As diffusion literature supports the flow of knowledge from developed countries to those that lag behind, it is an excellent business opportunity for companies to sell their products in developing regions around the world. Understanding the current industry and technology level in developing countries can help companies with advanced technologies to focus on products that would have applications in the chosen developing market segment. This is where the concept of customer value comes into play. While all technologies may have functional applications in the new developing region, they may not be very attractive to customers in terms of the value they offer at the time being. This allows the company looking to expand to the new segment to tailor their market entry approach by focusing on products that are beneficial at the moment and leave the more advanced technologies/applications for later when the value proposition is more attractive as the industry and technology levels develop.

An important factor that is often overlooked is that countries that lag behind have the opportunity to catch-up to developing countries in terms of technology evolution (Fagerberg & Verspagen, 2002). The biggest factor that contributes to this ‘catch-up’ is the rapid growth of innovative activity in the developing countries, with the prime example of South-Korea and Japan that managed to close the technology gap with other western technology leading countries in the early 1970’s and 1980’s (Fagerberg, 1987). The model for countries that manage to catchup technologically to develop countries is illustrated in the figure below.

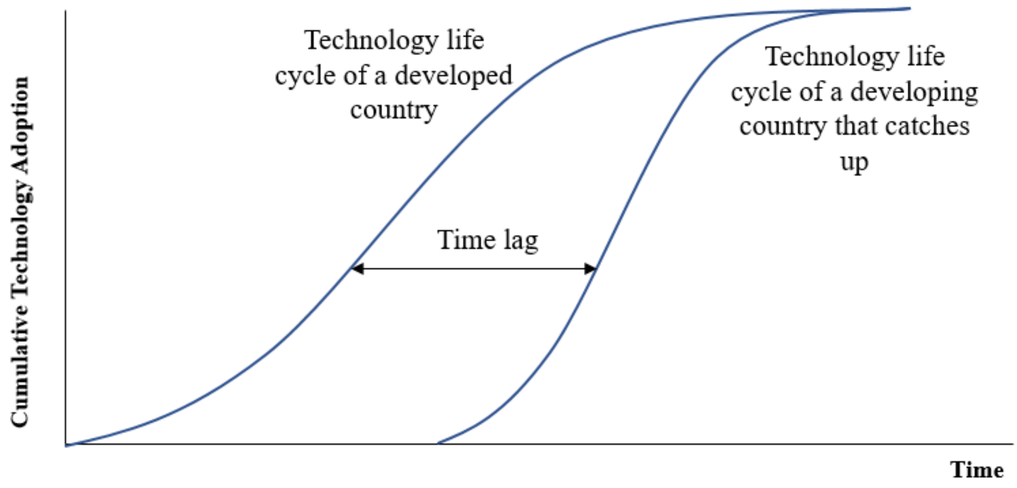

Figure 27. Framework for developing countries that catch-up to developing countries technologically.

Once the developing countries catches up to the developed countries in terms of technology evolution, there is no time lag between technology adoption. South-Korea and Japan are prime examples of countries that are at the same technology and innovation level as many other developed countries and have excellent economic development (Fagerberg & Verspagen, 2002).

As discussed in this chapter, developing countries lag behind in terms of industry evolution as well but like technology, it is possible for them to catch-up in industry evolution as well. Many developing countries start off with very low level of infrastructure and industry level when they form. In Chapter 2.1 it was discussed that countries meet local demand by regulating domestic production and imports (Vercammen & Schmitz. 1992). Most developing countries focus on developing local industry to meet demand in the country. With favorable policies developed by the government and other factors discussed in detail in Chapter 2.3 the industry evolution process can speed up leading to the developing country to catch-up to the developed countries. The model for developing countries catching up to developed countries in terms of industry evolution in shown in the figure below.

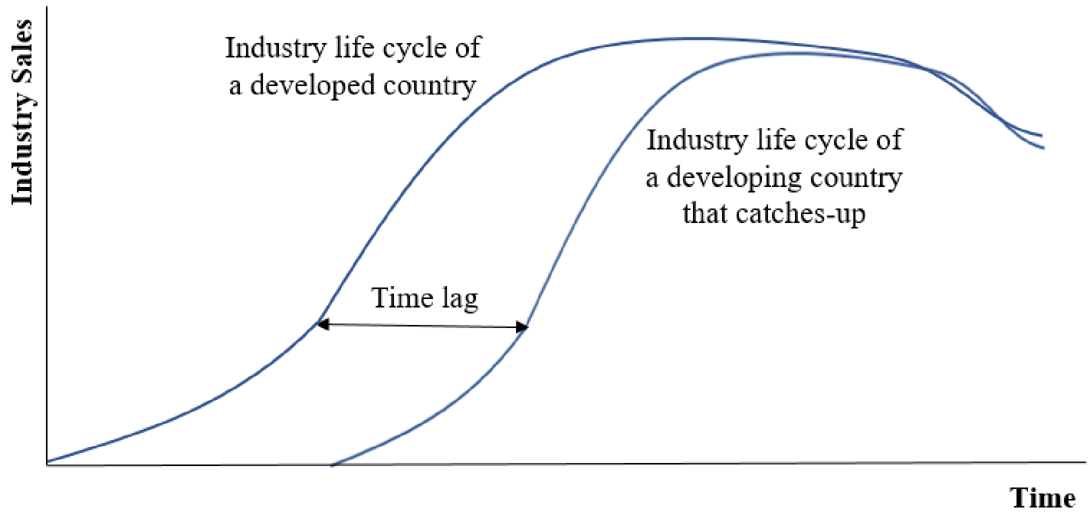

Figure 28. Framework for developing countries that catch-up to developing countries in industry level.

When evaluating the potential of a new technology for a market segment, the first step requires checking the overall industry sales to see the size of the industry. Annual production data for countries is rather easily available as the information is collected, maintained and published by government bodies. The discussion in Chapter 2.2 shows that the overall production volume and number of competitors is an excellent means to evaluate the industry level and check which stage it is in. While checking the industry level might be a good tool to evaluate the market segment it does not give any solid numbers to estimate the potential. To develop an estimate the proposed calculation is to utilize annual sales and population to compare two countries. The formula is shown below.

$$A = Ks$$

A represents the annual production, s is the annual sales from the company in the region and K is the constant that gives us the proportion between annual industry production and the total sales from the company in the region. The value of K can be calculated for a specific industry by finding the total annual sales from the company in a country where they already sell their products and using the overall annual production of the industry in the region. Then using the annual industry production and the value of K, the overall sales potential can be estimated for the target country that the company wants to enter.

While this is a good tool for estimation, plotting the annual production curve to develop an industry life cycle model can aid in evaluating the overall trend and see if the potential will grow or decline. The number of firms competing in the industry also helps in further evaluating the current stage of the industry life cycle in the target market. If the industry has just entered its growth phase and is currently showing low potential, it can be left to be focused on later while other industries that offer larger sales potential can be targeted.

The calculation from evaluating the industry evolution can show good potential which can be misleading. This brings evaluating the technology level of the target country into the mix. Evaluating the industry level to calculate the potential is not enough, it may be so that the target country lags behind in technology level hence it may not be able to utilize the new technology completely or efficiently. Hence the next step in analyzing the market potential is to see which applications offer the most customer value. The technology applications that offer low customer value can be left for later while market entry should be focused on the applications that offer good customer value. The framework for evaluating the market potential with industry and technology evolution is shown below.

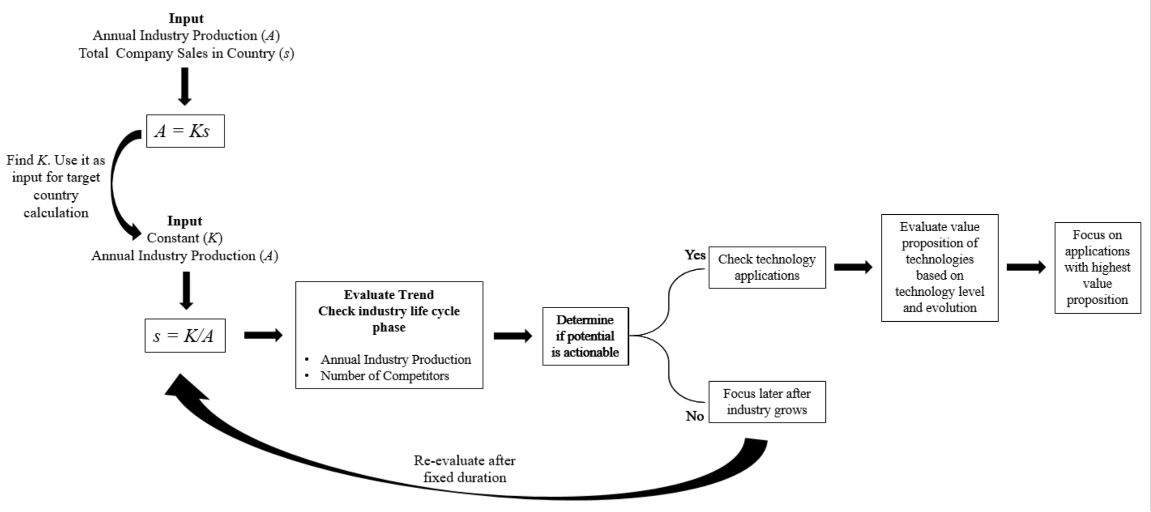

Figure 29. Framework for developing countries that catch-up to developing countries in industry level.

The framework above presents a systematic way to evaluate a chosen market segment for its sales potential. The process starts with choosing an industry and inputting its annual production along with the total sales made by the company in a country where they already operate. The next step involves calculating the value of the constant K and using it alongside the annual production in the new country being targeted to find the estimated sales potential. The sales potential is then analyzed further by checking the life cycle stage of the industry in the target country based on the annual industry production *A* and the number of competitors in the industry.

Based on the estimated value and the current life cycle stage it is determined if the chosen industry in the target country has actionable potential which is worth spending time, money and resources. If the answer is no, then the process is repeated after a set time duration to re-evaluate the potential. If the answer is yes, then the process moves onto identifying technology applications in the industry being evaluated. For each identified technology application, the value proposition is determined based on the technology level in the target country. The applications with the highest value offering are chosen as the focus for market entry to the new geographical region. The lowest are left for later and can be focused on when the technology level matures and the value proposition improves.

Chapter 6 analyzes the case company, their product offering, and sales in the key industrial sectors where they conduct business based on the framework which has been presented above. The target country is Pakistan, the industry and technology levels will be analyzed using the framework in this section for the application of the case company's products to see the business potential in the region and see which technology applications offer the highest value proposition.

6. ANALYZING THE NEW MARKET SEGMENT

6.1 The case company

The case company is a instrumentation manufacturer that also does R&D and testing at their facility. The company has over 50 years of experience in their field of business and is located in Finland. With a distributor channel that spans 25 countries they have a global reach and sales all over the world. The figure below shows the breakdown of their sales for 2017.

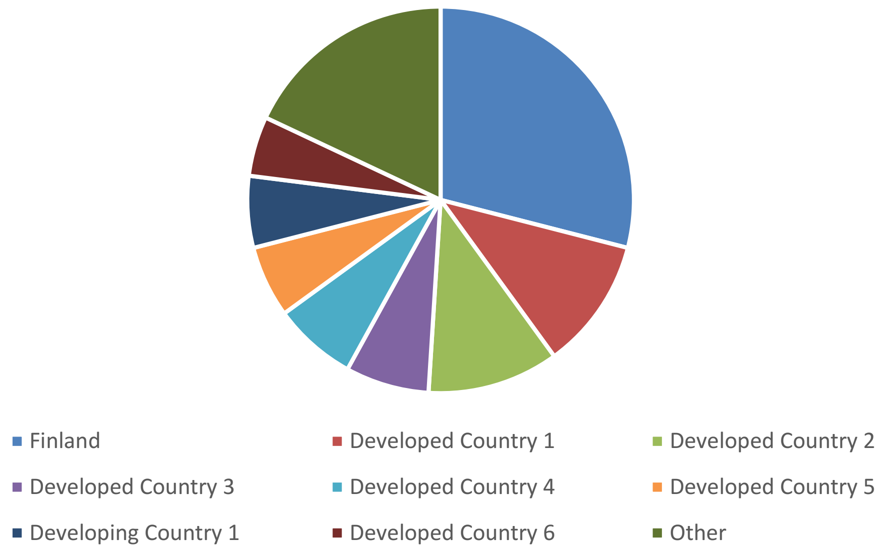

Figure 30. Sales of case company in 2017 by country.

In the figure it can be seen that most of the case company's sales are in developed countries. Recently, the case company has expanded its business to India, which is a new promising market, using a local distributor to reach potential clients in the region. Since the CEO of the company found the sales in India to be promising, he started looking for other potential countries in the region to sell their products to.

Pakistan is a neighbor of India and has a very similar economic and cultural environment. With a population of more than 200 million and an agricultural economy, it was an excellent country to find potential sales leads in. This was the beginning of discussions regarding selling the case company's products in Pakistan by finding industries where they could offer potential advantage and hence lead to sales.

The product offering of the case company includes pressure, level, turbidity, and consistency sensors. They also manufacture mounting and save sampling valves. These products have applications in the pulp and paper industry, food and beverage industry, and the chemical industry.

The largest sectors for the case company's sales are pulp and paper along with food and beverage. To develop an estimate of the annual sales for both the segments the division is made at 40% pulp and paper, 40% food and beverage and 20% process industry. The following figures are calculated based on the case company's 2016 global sales of 5 million euros. Pulp and paper 2 million euros, food and beverage 2 million euros and the process industry 1 million euros.

Finland accounts for 29% of their overall annual sales. This gives the pulp and paper industry in Finland a value of 0.58 million euros per annum, the food and beverage industry 0.58 million euros per annum and the process industry 0.29 million euros per annum. These industry specific industry sales values will be used in the following sections.

Since the case company expressed interest in starting off sales in Pakistan with the dairy sector, the technology applications for the sugar industry were not made part of the thesis on their request of the case company's upper management. The case company's products are certified by the leading food and health organizations around the world, which makes them some of the safest and most hygienic products to use in the food and beverage industry. The key applications for their products are:

- Waste water monitoring
- Leakage control in heat exchangers
- Clean in Place (CIP)

First, waste water monitoring gives important information to the manufacturing company about the efficiency of the dairy plant. Being able to detect a large amount of organic leakage in the waste water allows for a quick response to fix the issue and treat the waste water before it is dumped. Problems within dairy like leaking cream or milk valves, leaking milk trucks, or leakage in the manufacturing facility can be monitored. Leakage of organic material into the waste water which is dumped can cause bacterial growth in water to speed up. Bacterial growth in lakes and rivers can lead to bad odor and lack of oxygen in water for fish to breathe, causing them to die. This is why leakage of organic material in waste water is heavily fined in developed countries to protect wildlife and protect the environment. Using the case company's products helps the dairy industry avoid these incidents by monitoring leakages, saving not only a lot of money that would have to be paid in fines and penalties but also protecting the environment.

Second, leakage control in heat exchangers offers an excellent application in terms of keeping the process hygienic at dairy plants. Milk that comes from farms is chilled on arrival to dairy plants. This is done by using ice water and circulating the dairy and the chilled water in heat exchangers to bring down the temperature of the milk. A leakage or breach of the heat exchangers can lead to contamination of the storage tank at the dairy facility, causing a loss of milk and time. The case company's products allow monitoring contamination in real time helping to avoid hyenine issues like this at dairy facilities.

Third, the real time Clean in Place (CIP) monitoring. Before the CIP process, dairy facilities would disassemble all the pipes and process fittings and clean them manually. After the CIP process got introduced in the 1950's, dairy manufacturers were able to clean their equipment quickly and efficiently, as the need for manual work was eliminated. Usually the CIP process is carried out between two cycles and involves multiple stages like rinsing with clean water, using sodium hydroxide in the alkaline phase and nitric acid in the acidic phase of the process. The process can vary depending on the dairy processes being carried out and the manufacturer. The case company's products offer excellent application in optimization of the CIP process by offering real time monitoring solutions, reducing the cycle time and saving expensive CIP chemicals.

6.2 Industry and technology evolution of pulp and paper industry

Given the reasonable success that the case company has had in India through a new distributor, they decided to look for other markets in the region which may offer considerable business potential. Since Pakistan is a neighboring country to India and has a very similar economical environment with a population of more than 200 million people, it was an interesting area to focus on.

To judge the potential of the case company's products in Pakistan, an analysis of the current industry was done for the pulp and paper and food and beverage industries in light of the developed framework, to identify the technological applications that offered the most potential because of the attractive value offering to the customers. The pulp and paper industry analysis will be done first, followed by the food and beverage industry.

Pakistan gained its independence in 1947. At this time, there were no pulp and paper mills in Pakistan (Ansari, 1990). Despite a large demand in the country, the needs were met through imports as the industry growth remained slow in the beginning. Ansari (1990) puts paper production in Pakistan at 1947 at 0 and then in 1989 at 229,000 tons. Akhtar et al. (2013) report that there are about 100 units in Pakistan from the organized and unorganized sector combined. Collectively these units have a production of 650,000 tons per annum (Akhtar et al., 2013). In million tons this comes out to be 0.65 million tons per annum. While annual production data of pulp and paper in Pakistan is not readily available from public resources, this gives production data for three years which is shown in the table below.

Table 15. Production data of pulp and paper in Pakistan.

Year	Production (million tons)
1947	0
1989	0.229
2013	0.65

The Finnish Forest Industries Federation puts the production of Finland in the year 2013 at 6.307 million tons (Suorsa, 2017). The production data of Finland has been well documented is shown in the table below.

Table 16. Annual production data of pulp and paper in Finland (Adapted from Suorsa, 2017).

Year	Production (million tons)	Year	Production (million tons)
1961	1.237	1989	5.831
1962	1.259	1990	6.111
1963	1.336	1991	6.01
1964	1.499	1992	6.236
1965	1.706	1993	6.927
1966	1.837	1994	7.542
1967	1.78	1995	7.723
1968	1.886	1996	7.147
1969	2.078	1997	8.575
1970	2.229	1998	9.174
1971	2.292	1999	9.314
1972	2.605	2000	9.736
1973	2.92	2001	8.876
1974	2.964	2002	8.953
1975	2.287	2003	9.251
1976	2.519	2004	10.024
1977	2.664	2005	8.816
1978	3.03	2006	10.01
1979	3.391	2007	9.768
1980	3.596	2008	8.834
1981	3.796	2009	6.856
1982	3.672	2010	7.466
1983	3.995	2011	7.323
1984	4.848	2012	6.612
1985	4.978	2013	6.307
1986	5.012	2014	6.093
1987	5.317	2015	5.924
1988	5.773	2016	5.511

Using the case company's annual sales in Finland from Chapter 6.1 and the annual industry production for 2013 in the table above the value of K can be calculated as proposed in the framework.

$$A = Ks$$

$$K = A/s$$

$$K = 6.307/0.58$$

$$K = 10.874$$

Based on this value of *K* we use the annual production data of the pulp and paper industry in Pakistan to find the value of *s*. The calculation for the sales potential *s* is shown below.

$s = A/K$

s = 0.65/10.874

s = 0.0598

The annual sales potential comes out to be 0.0598 million euros per year. Comparing this to the annual sales of 0.58 million euros in Finland the potential seems low. The next step of the framework involves analyzing the industry life cycle phase. The figure below shows the production figures for Finland plotted to show a more graphical illustration.

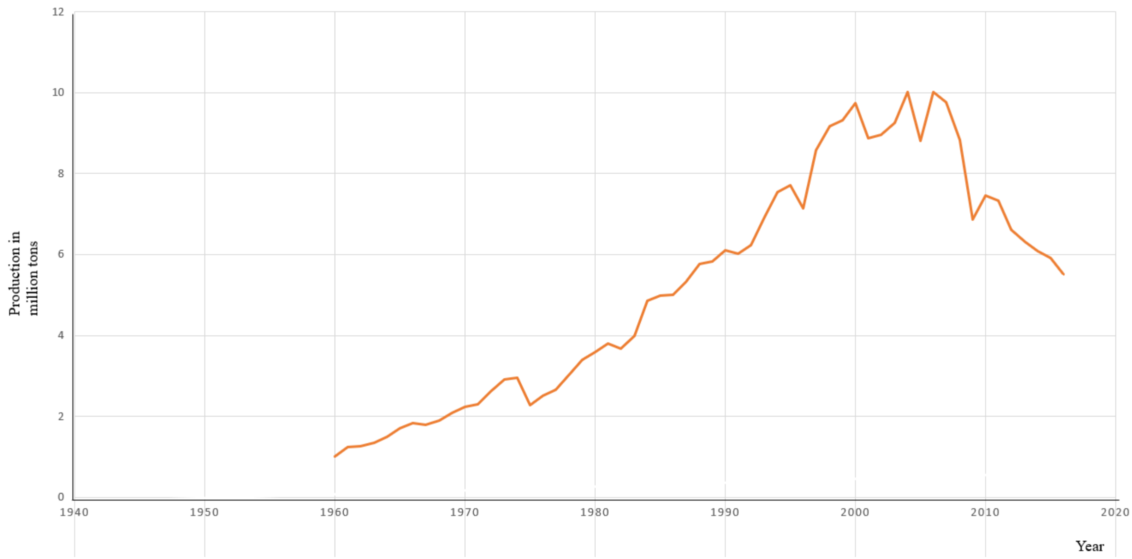

Figure 31. Annual production of paper in Finland (adapted from Suorsa, 2017).

The increase in the paper production in Finland from 1960's to the 1990's shows the industry life cycle being in the growth phase. From the mid 1990's to 2005 the industry can be seen in its maturity and then slowly moving towards its decline. The figure above takes the shape of the general industry life cycle model that all industries follow, which supports the framework developed in this thesis. The figure below shows the graphical illustration of the production data of pulp and paper in Pakistan based on the information which was available.

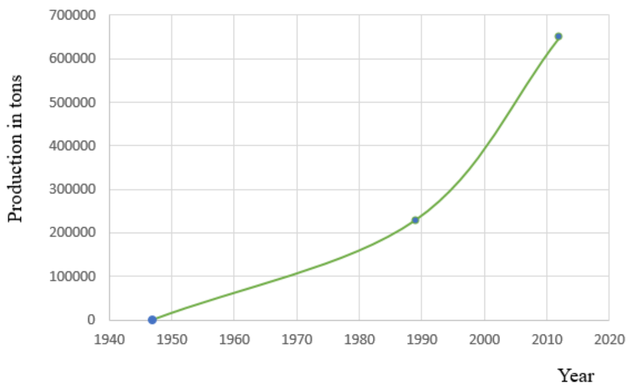

Figure 32. Annual production of paper in Pakistan.

The figure above shows an upward trend in local production of paper in Pakistan. While the data is limited, plotting a curve using a smooth line shows a shape similar to the beginning of the growth phase in the industry life cycle model. Comparing the data provided by Ansari (1990) and Akhtar et al. (2013), there has been around 400% increase in production in 24 years. The increased growth and high number of firms present in the local industry all mark the industry life cycle of the pulp and paper industry in Pakistan to be in the growth phase. Pakistan still relies on imports to meet its local demand, which contributes to the successful growth of the local industry. In the figure below, both life cycle curves based on production data of Finland and Pakistan are plotted in one graph.

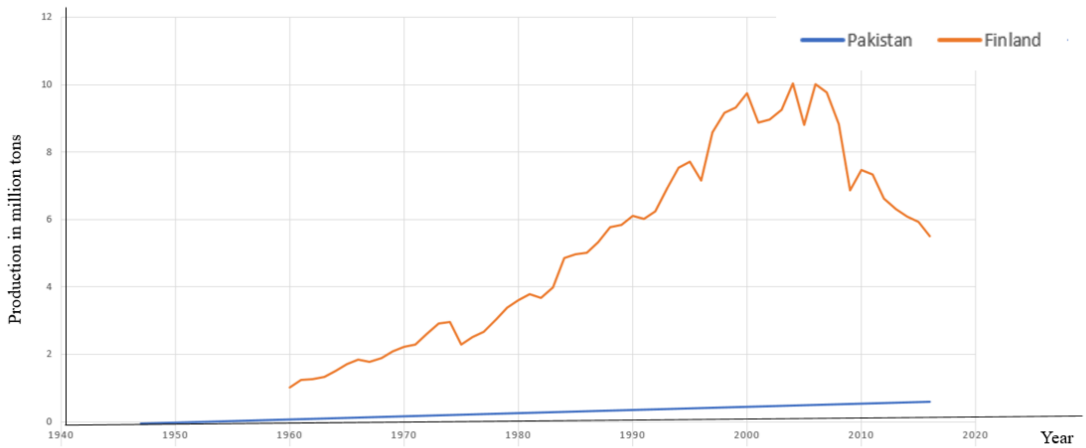

Figure 33. Annual production of paper in Pakistan and Finland.

In the figure above, it can be seen that there is a very big difference in the overall production volume of the pulp and paper industry in Pakistan and Finland. This makes it difficult to compare the shape of the curves between the two countries. The figure below shows the two curves adjusted by scaling them as a percentage of the overall highest recorded production volume.

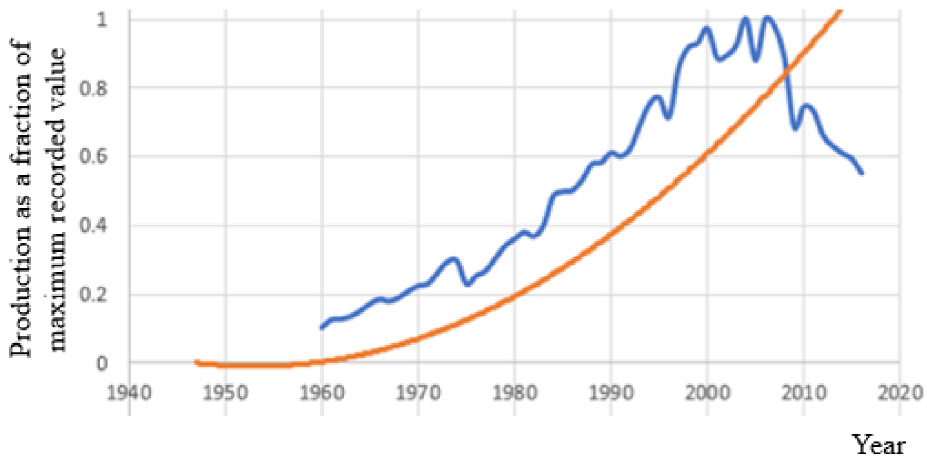

Figure 34. Annual production of paper in Pakistan and Finland.

It should be noted that the graphical representation in the figure above is using scaled values in the Y-Axis. All values are fractions of the maximum recorded value which creates a graph which ignores the sales volume and allows a better comparison between the shapes of the curves. These results can be compared to the theoretical model of the industry life cycle. The table below gives a breakdown of the different stages of the industry life cycle model for the Pulp and Paper Industry in Pakistan and Finland.

Table 17. Life Cycle Stages of Pulp and Paper Industry in Pakistan and Finland.

Life Cycle Stage	Finland	Pakistan
Introduction	1917 - 1975	1947 - 1990
Growth	1975 – 2000	1990 – Present
Maturity	2000 – 2007	
Decline	2007 - Present	

A clear lag between the life cycle stages can be seen between Pakistan and Finland in the table above. Pakistan entered the introduction and growth phases after Finland. The Finnish Pulp and Paper Industry has already moved into the stage of decline, while the Pakistani industry seems to be in the beginning of its growth phase. The number of competitors in the Pakistani industry is estimated to be around 100 companies in the organized and unorganized sector (Akhtar et al., 2013). Based on the framework, a high number of competitors and increasing annual production confirms the pulp and paper industry in Pakistan to be in its growth phase. With this data, the theoretical model proposed in this thesis is justified using empirical evidence.

While the findings are interesting from a theoretical stand point, the overall low production volume of the pulp and paper industry in Pakistan shows a market segment that lacks business potential from the case company's perspective as the overall potential of 0.0598 million euros per annum is too low to consider investing time and resources at the moment. The suggestion as based on the developed framework would be to reanalyze the potential and life cycle stage in a few years to see if the sales potential is actionable as the Pakistani pulp and paper industry moves further into its growth stage. The table below summarizes the findings of the analysis in light of the framework.

Table 18. Market analysis summary of pulp and paper industry in Pakistan.

Industry Sector	Value of *K*	Sales Potential *(s)*	Life Cycle Stage in Pakistan	Number of Potential Customers in Pakistan	Actionable Potential	Technology Applications	Technologies with highest value proposition
Pulp and Paper	10.874	0.0598	Growth	100	No	Revisit when potential is actionable	Revisit when potential is actionable

The table gives a systematic overview of the market analysis of Pakistan regarding the pulp and paper industry. Since the overall potential *s* is calculated to be 0.0598 million euros per year and the industry is in its growth phase it is advised that the sector should be re-evaluated later as the local industry grows. This brings the case to the next important business segment that the case company caters to, which is the food and beverage sector which will be analyzed in the next section.

6.3 Industry and technology evolution in the food and beverage industry

The previous section looked into justifying the framework built in this thesis with empirical evidence and analyzing the pulp and paper market segment in Pakistan using publicly available data of the industry in Finland and Pakistan. This section will analyze the food and beverage sector in Pakistan to identify business potential for the case company.

As of 2017, Pakistan is the 5th largest country in the world by population according to the Pakistan Bureau of Statistics. Agriculture is a large part of the economy, standing at 20.9% in 2014-2015 as stated in the data published by the Ministry of Finance of Pakistan. Since agriculture is a large part of the economy, it makes Pakistan an interesting geographical market to look at in terms of the food and beverage industry for selling the case company's products.

According to the data collected by the Food and Agriculture Organization in 2014-2016, Pakistan ranked as the 5th largest producer of sugarcane in the world. Pakistan was also ranked as the 4th largest producer of milk in the world according to the Food and Agriculture Organization, with the majority of the milk coming from buffalos. Given the large production figures of milk and sugar and the large population, the case company decided to have a study conducted for application of their products in Pakistan.

The study of the sugar industry and the milk processing industry has been conducted using mostly publicly available data. First, the sugar industry will be evaluated. Pakistan has two major official organizations dealing with the sugar mill manufacturers. The first is the Pakistan Sugar Mills Association (PSMA) which is a government organization responsible for collecting yearly data and regulating policies regarding the sugar mills in Pakistan. The second is the Pakistan Society of Sugar Technologies (PSST). The PSST helps organize events and work towards development of the sugar mill technology in Pakistan by looking into optimization measures and helping the industry flourish.

PSMA has 89 sugar mills registered in Pakistan from all four provinces combined as of 2016. Through research and using publicly available data, contact information and the location of 78 mills and their head offices has been identified. This list will be provided separately to the case company and has not been included in this thesis. PSMA has published the following figures of sugar production in Pakistan from 1990 to 2016.

Table 19. Annual sugar production in Pakistan (Adapted from PSMA, 2018).

Year	No of Mills	Cane Crushed Tonnes	Sugar Made Tonnes	Recovery (%)	Beet	Raw	Total in Tonnes
1990-91	51	22,603,696	1,908,838	8.44	23,312		1,932,150
1991-92	53	24,795,815	2,296,698	9.25	29,009		2,325,707
1992-93	61	27,274,806	2,375,289	8.71	18,916		2,394,205
1993-94	63	34,181,899	2,900,523	8.49	21,933		2,922,457
1994-95	66	34,193,290	2,983,101	8.72	18,370		3,001,472
1995-96	66	28,151,434	2,449,598	8.7	20,435		2,470,034
1996-97	68	27,152,918	2,378,751	8.76	14,610		2,393,361
1997-98	71	41,062,268	3,548,953	8.64	6,267		3,555,220
1998-99	71	42,994,911	3,530,931	8.21	10,831		3,541,763
1999-00	69	28,982,711	2,414,746	8.33	14,618		2,429,364
2000-01	65	29,408,879	2,466,788	8.39	17,276	531,930	3,015,994
2001-02	69	36,708,638	3,197,745	8.71	29,172	22,111	3,249,029
2002-03	71	41,786,689	3,652,745	8.74	22,066	1,945	3,676,759
2003-04	71	43,661,378	3,997,010	9.15	23,797		4,020,806
2004-05	71	32,101,739	2,922,126	9.1	11,373	182,302	3,115,801
2005-06	74	30,090,632	2,588,177	8.6	8,934	401,396	2,988,507
2006-07	77	40,483,977	3,516,218	8.69	7,865	2,860	3,526,943
2007-08	78	52,776,922	4,740,913	8.98	5,532	5,929	4,752,374
2008-09	82	33,139,418	3,134,145	9.46	947	----	3,135,092
2009-10	83	34,611,003	3,133,494	9.05	4,641	----	3,138,135
2010-11	84	44,511,571	4,119,421	9.25	13,535	39,679	4,172,726
2011-12	86	48,248,535	4,670,380	9.64	18,216	-	4,670,380
2012-13	86	50,089,483	5,030,129	10.04	33,028	-	5,063,158
2013-14	88	56,460,524	5,587,568	9.9	27,389	-	5,614,957
2014-15	89	50,795,218	5,139,566	10.12	22,727	-	5,162,293
2015-16	89	50,042,249	5,082,110	10.16	32,791	-	5,114,901

From the table above, the data regarding production of sugarcane, beet sugar and the number of mills can be seen. In order to find the value of K, the annual production data of sugar from Finland is also needed. One key thing to note regarding the production data from Finland and Pakistan is that the majority of sugar made in Pakistan is from sugarcane while in Finland sugar comes from beets. The annual sugar production data of Finland gathered from public resources is shown in the table below, the data is taken from Knoema (2018) which collect their data from the Food and Agriculture Organization.

Table 20. Annual sugar production in Finland (Adapted from Knoema, 2018).

Year	Annual Production (tons)		Year	Annual Production (tons)
2016	433,600		1988	1,004,600
2015	406,500		1987	466,200
2014	626,300		1986	843,000
2013	480,400		1985	739,400
2012	398,700		1984	823,400
2011	675,700		1983	955,000
2010	542,100		1982	756,100
2009	559,000		1981	680,500
2008	468,000		1980	900,200
2007	673,100		1979	700,000
2006	952,000		1978	722,100
2005	1,181,300		1977	555,200
2004	1,063,500		1976	588,000
2003	892,300		1975	629,500
2002	1,066,300		1974	629,100
2001	1,105,200		1973	607,000
2000	1,046,000		1972	662,000
1999	1,172,100		1971	463,500
1998	892,000		1970	430,600
1997	1,360,000		1969	337,100
1996	896,600		1968	386,200
1995	1,110,000		1967	432,300
1994	1,096,900		1966	457,200
1993	996,000		1965	407,500
1992	1,049,000		1964	430,948
1991	1,042,800		1963	455,233
1990	1,125,000		1962	366,669
1989	989,800		1961	456,120

Based on the framework the first step of the process is to find the value of *K*. Given the annual sales in 2016 for Finland were 0.58 million euros for the food and beverage industry, it needs to be further divided among the sugar and dairy industry. Since the sugar industry sales are lower than the dairy industry for the case company the division is done at 25% and 75%. This gives us annual sales in Finland for the sugar industry to be 0.145 million euros per annum and the dairy industry to be 0.435 million euros per annum. With this and the production data from the table above, the value of *K* can be calculated.

$K = A/s$

$K = 0.4336/0.145$

$K = 2.99$

Based on this value of *K* and the annual production data of the pulp and paper industry in Pakistan, the value of *s* is calculated. The calculation for the sales potential *s* is shown below.

$s = A/K$

$s = 5.115/2.99$

$s = 1.71$

The sales potential for the case company in the sugar industry of Pakistan turns out to be 1.71 million euros per annum. This is an extremely attractive industry segment for the case company to consider with more than 10 times the potential of Finland but before making any conclusions the next step of the framework proposes analyzing the life cycle model of the Pakistani sugar industry to strengthen the market analysis. Using the production data from the tables above some interesting graphical representations can be developed. The figure below uses the production figures and plots them against the year they were collected to show the overall growth in industry in Pakistan.

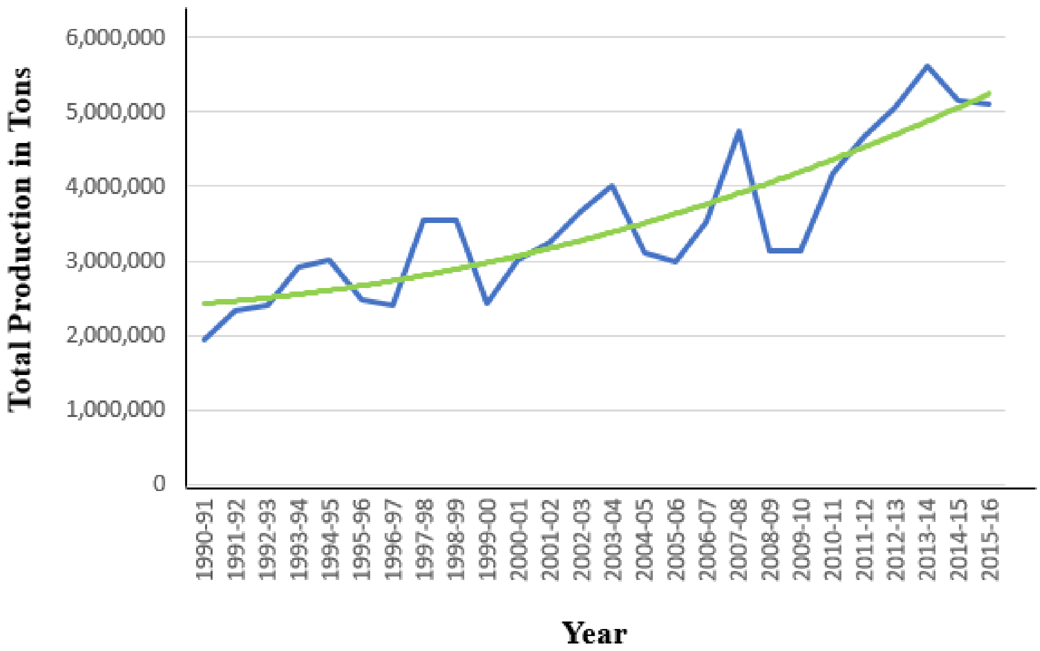

Figure 35. Annual production of sugar in Pakistan.

The blue line in the figure above shows the actual production data plotted against the year it was collected, and the green line is a smooth curve to create a trend line for comparison to the framework developed in the thesis. The smoothened line shows a growth trend which is the second phase of the industry life cycle model. The annual production of sugar in Finland is plotted in the figure below.

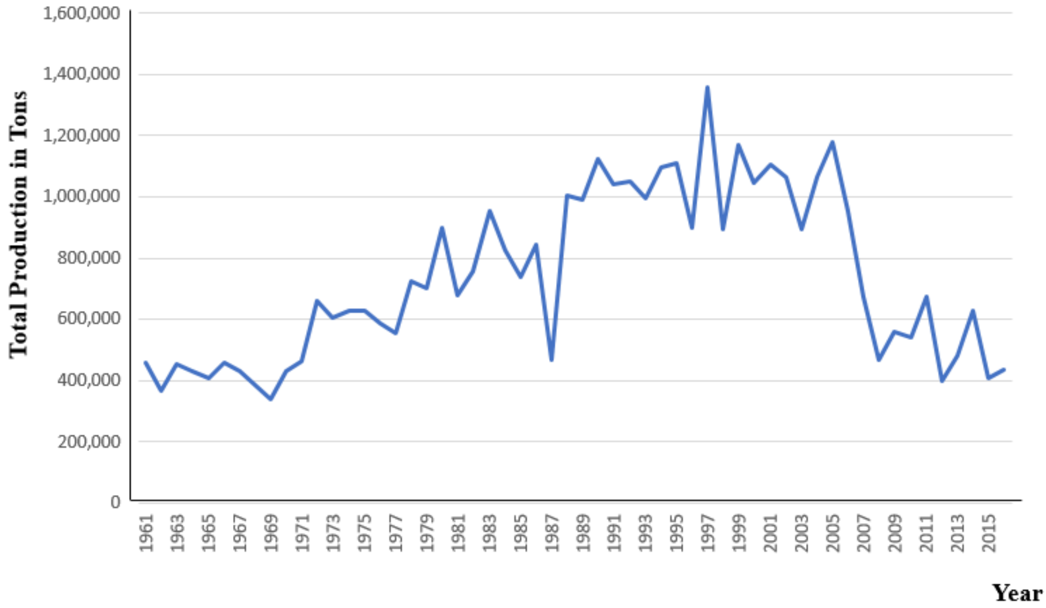

Figure 36. Annual production of sugar in Finland.

The figure above shows the annual production of sugar in Finland from beets. The shape of the graph shows that the Finnish sugar industry has entered its decline stage while the sugar industry in Pakistan is in its growth phase. The figure below compares the production data from both countries in a single graph.

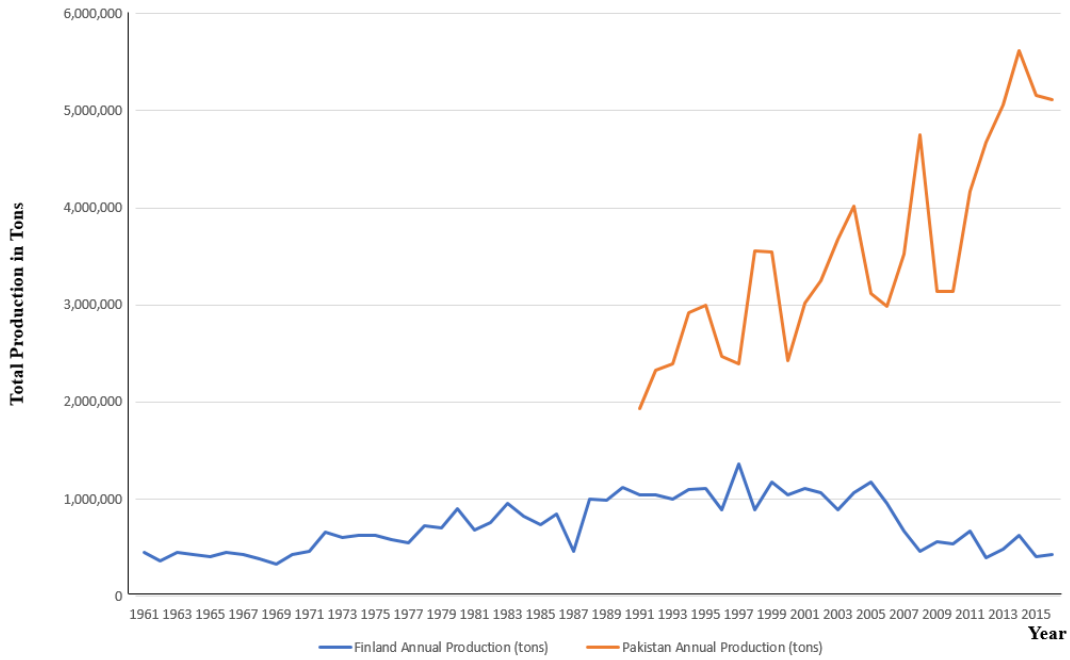

Figure 37. Annual production of sugar in Finland and Pakistan.

The side by side plotting of the production curves from both countries shows the Pakistani sugar industry to be in its growth phase while having a much larger potential due to its very high production volume. To further strengthen the argument presented, the number of mills in Pakistan vs the year has been plotted in the figure below as suggested by the framework.

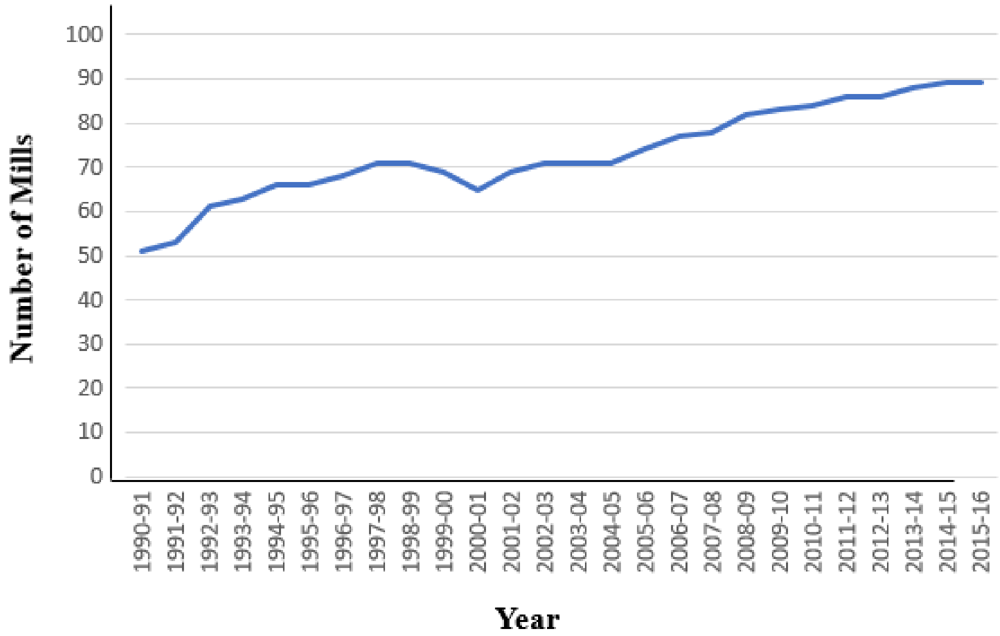

Figure 38. Number of mills in Pakistan.

In the figure above, it can be seen that the number of mills has been steadily growing over the years. In 1990 there were 51 mills in Pakistan, and in 2016 the number has grown to 89. There has been a 174% increase in the number of mills and the sugar production has grown by 264% from 1990 to 2016. Going back to the framework, it can be confirmed that the empirical evidence supports the theory that growing number of competitors in the market and increasing annual production points to the Pakistani sugar industry to be in its growth phase. The breakdown of the phases for each country is shown in the figure below.

Table 21. Life Cycle Stages of sugar industry in Pakistan and Finland.

Life Cycle Stage	Finland	Pakistan
Introduction	1917 - 1970	1947 - 1990
Growth	1970 – 2000	1990 – Present
Maturity	2000 – 2005	
Decline	2005 - Present	

The production figures and growing number of mills and competitors in the region makes it an excellent market for the case company. This brings the market evaluation to the next step of understanding the technology level of the sugar industry in Pakistan. Pakistan, being one of the largest producers of sugar in the world, is also a major player in sugar export. This is a major reason that the PSMA controls the final price of sugar in Pakistan.

The controlled final price leaves sugar manufacturers with smaller margins, which in turn generated a demand for these industries to continuously look for process optimization and newer technologies to improve their capabilities to reduce their costs and save money (Khan, 2013). This is one of the major reasons for the creation of PSST which looks into newer technologies and methodologies to keep the sugar manufactures updated on techniques to keep improving their production processes. Given the specialized equipment developed by the case company for the sugar industry, the growing trend of the Pakistani market and little to no lag in the technology level, the recommendation is to move ahead with investing time and resources to enter the region. The figure below illustrates that the Pakistani sugar industry has caught up to the Finnish sugar industry in terms of technology evolution. This means that in the future, the new technology applications developed by the case company for the developed countries can be applied to Pakistan as well due to its attractive value proposition.

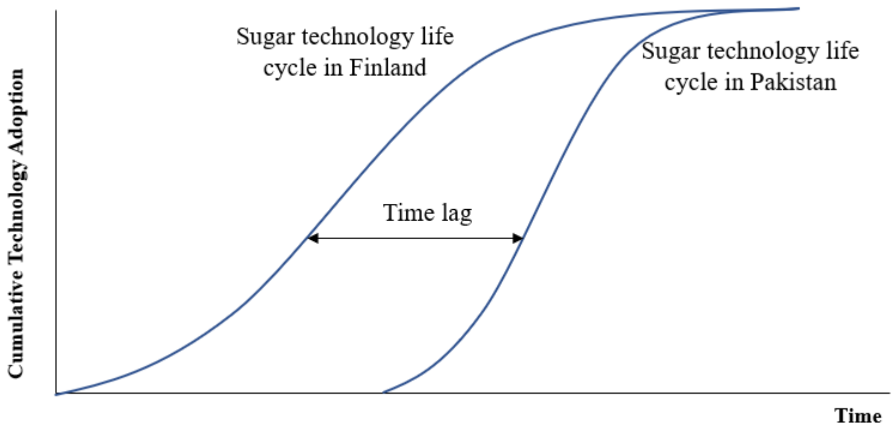

Figure 39. Technology evolution of Pakistani sugar industry.

However, the case company has shown interest in targeting the dairy sector before focusing on the sugar industry. Hence on their request, the application analysis was performed on the dairy technologies only as some of their sugar technology applications are still in the process of development and may take some time before they are ready to be sold outside Europe. The table below summarizes the findings of the market analysis regarding the sugar industry in Pakistan in light of the developed framework.

Table 22. Market analysis summary of sugar industry in Pakistan.

Industry Sector	Value of *K*	Sales Potential *(s)*	Life Cycle Stage in Pakistan	Number of Potential Customers in Pakistan	Actionable Potential	Technology Applications	Technologies with highest value proposition
Sugar Industry	2.99	1.71	Growth	89	Yes	Revisit when case company is interested	All technology applications

The next industry to be evaluated is the dairy industry in Pakistan. As mentioned earlier, the Food and Agriculture Organization ranks Pakistan as the 4th largest producer of milk in the world according to their statistics in 2013. The production figures of milk in Pakistan in shown in the table below.

Table 23. Annual Production of Milk in Pakistan (Adapted from Zia et al., 2011).

Year	Production (million tons)		Year	Production (million tons)
1998-1999	30.34		1998-1999	16.54
1999-2000	31.17		1999-2000	15.18
2000-2001	32.05		2000-2001	7.44
2001-2002	32.95		2001-2002	4.37
2002-2003	33.9		2002-2003	8.81
2003-2004	34.89		2003-2004	4.68
2004-2005	35.9		2004-2005	8.37
2005-2006	38.12		2005-2006	20.17
2006-2007	39.36		2006-2007	22.26
2007-2008	40.64		2007-2008	10.25

The data for annual milk production of Pakistan has been taken from Zia et al. (2011). The figure below shows the annual production of milk from the years 1998 to 2008 as the production information is not readily available for the years afterwards. Andaleeb & Khan (2017) put the milk production of 2014-2015 at 52.63 million tons. This indicates a continued steady growth of annual milk production in Pakistan. The annual milk production data for Finland has been gathered from the National Resources Institute of Finland. The production data is shown in the table below, the data is taken from Luke (2018), the Natural Resources Institute Finland.

Table 24. Annual Production of Milk in Finland (Luke, 2018).

Year	Production (Million tons)
1990	2.600
1991	2.345
1992	2.274
1993	2.264
1994	2.316
1995	2.296
1996	2.261
1997	2.301
1998	2.294
1999	2.325
2000	2.371
2001	2.378
2002	2.376
2003	2.323
2004	2.304
2005	2.293
2006	2.279
2007	2.226
2008	2.188
2009	2.215
2010	2.222
2011	2.190
2012	2.188
2013	2.220
2014	2.289
2015	2.325
2016	2.320
2017	2.297

The annual production information from the tables above allows the calculation of *K* as proposed by the framework. Since the annual sales value for the dairy industry in Finland was calculated to be 0.435 million euros per annum, it gives the value for *s*. The calculations are shown below.

$K = A/s$

$K = 2.325/0.435$

$K = 5.345$

Based on this value of *K* and the annual production data of the dairy industry in Pakistan the value of *s,* the potential sales is calculated. The calculation for the sales potential *s* is shown below.

$s = A/K$

$s = 52.63/5.345$

$s = 9.847$

The sales potential turns out to be 9.847 euros per annum. The extremely high value of potential sales is due to the immense size of the Pakistani dairy industry. While the value itself is very attractive, life cycle of the dairy industry has to be analyzed to further strengthen the market potential analysis based on the developed framework. The figure below plots the annual dairy production data of Pakistan.

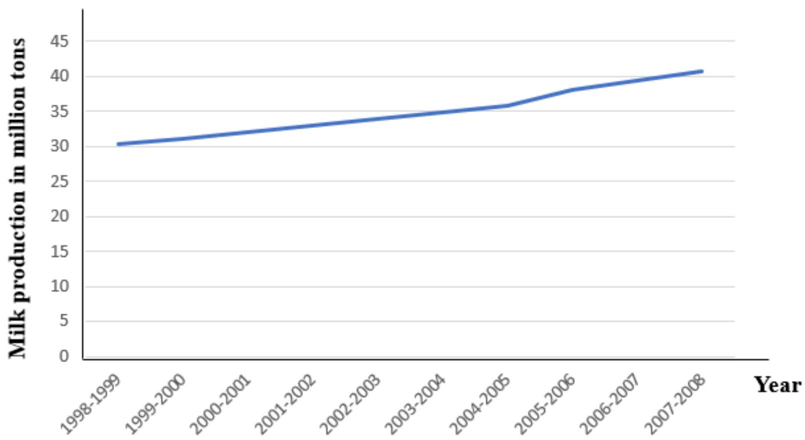

Figure 40. Annual production of milk in Pakistan.

The figure above shows a steady growth in annual milk production based on the FAO report from Zia et al. (2011). The figure below shows the annual production of milk in Finland plotted as a graph.

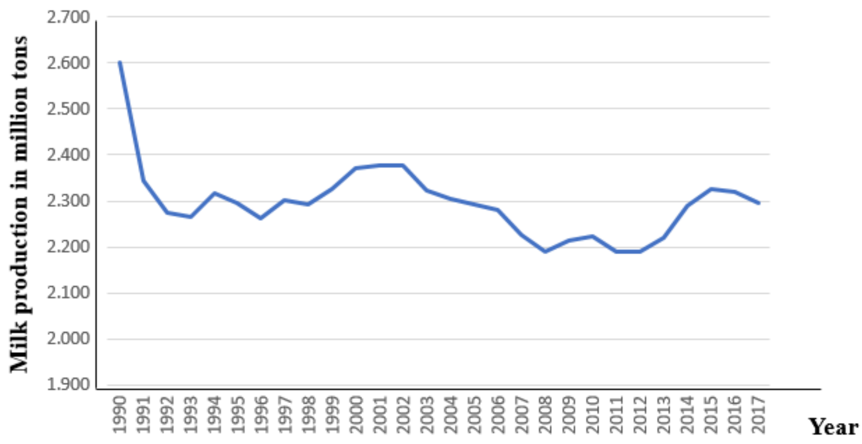

Figure 41. Annual production of milk in Finland.

In the figure above, it can be seen that the Finnish dairy industry has entered its decline stage, while the production in Pakistan is growing steadily. However, Pakistan has been facing a shortage of milk due to its growing population and has had to import milk to meet the local demand. A FAO sponsored study in 2003 by the Social Science Institute NARC estimated the total gap between production and consumption to be 3.5 million tons. This gap was forecasted to increase by 2020 to 55.48 million tons. The figure below shows the data for milk imports from 1998 to 2008. (Zia et al., 2011)

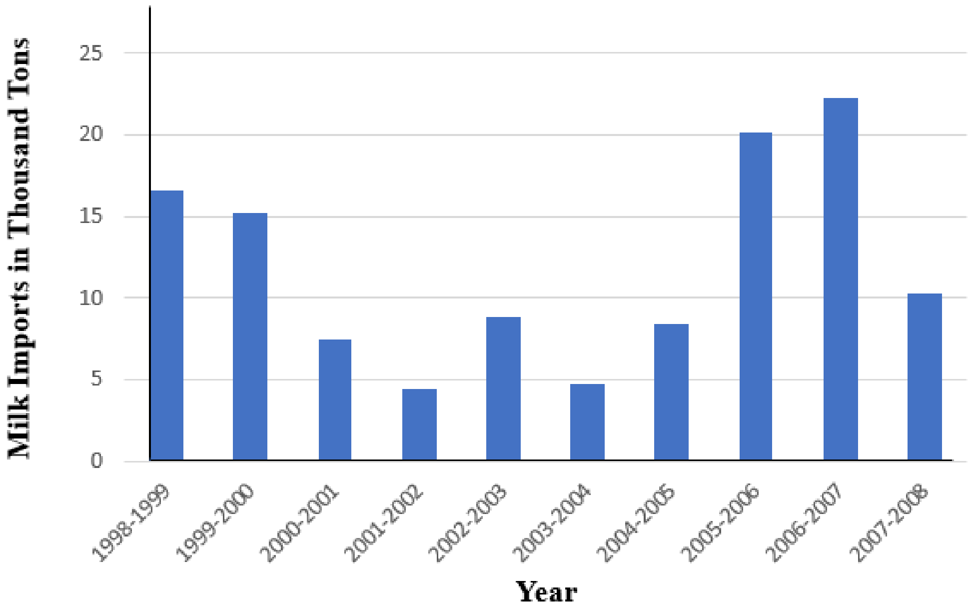

Figure 42. Annual import of milk in Pakistan.

The figure above shows that despite Pakistan being one of the largest producers of milk in the world, there is a continuous need to import milk to due growing local demand. Based on the estimates from Zia et al. (2011) if the demand and production gap grows by

2020, it is a sign of slowing down of industrial growth in the milk sector of Pakistan. Slowing down of growth according to the industry life cycle model indicates that the sector is about to enter the stage of maturity. This is also backed up by data regarding the number of key players in the dairy processing industry in Pakistan. There are about 17 key large-scale milk processing industries in Pakistan today. The low number of competing industries in the region is a good indicator of the sector entering the maturity stage of the industry life cycle model, as mentioned in the framework. The data collected regarding the 17 key players in the Pakistan industry will be submitted to the case company separately. The figure below shows the life cycle stages of the dairy industry in Pakistan and Finland.

Table 25. Life cycle stages of the dairy industry in Pakistan and Finland.

Life Cycle Stage	Finland	Pakistan
Introduction	Data Unavailable	Data Unavailable
Growth	Data Unavailable	Data Unavailable - 2004
Maturity	Data Unavailable - 1992	2004 - Present
Decline	1992 - Present	

Early data of dairy production in Finland and Pakistan was unavailable through public resources but production data of recent years was enough to analyze which state the dairy industry is currently in Pakistan and Finland. While all signs of the milk industry are positive for the case company to consider selling their products to the dairy sector in Pakistan, a closer look needs to be taken at the technology level of the industry as it is the next step of the developed framework. As mentioned in earlier, three areas of application for their products are waste water management, leakage control into heat exchangers and optimizing the CIP process. The figure below breaks down the benefit each application offers to the dairy processing plant based on the value proposition.

Table 26. Analyzing the value proposition of the case company's product applications in Pakistan.

Application	Value Offered	Value Proposition	Reason
Waste Water Management	Controlling and monitoring leakage of organic material into lakes and rivers. Protect fish and growth of bacteria which leads to bad odour. Heavy penalties and fines from government because of leakages.	Poor	Poor implementation of environmental protection rules. Reduced motivation for dairies to monitor their waste water. No penalties causes and lack of environmental awareness leads to no interest in controlling organic waste.
Leakage Control in Heat Exchangers	Hygiene issues by contamination of milk with ice water.	Average	Application only in high end companies that use excellent hygienic processing of milk as a selling point.
CIP Process Optimization	Process optimization, cost reduction, cycle time reduction, chemical savings and water savings.	Excellent	Process optimization and reduction of cycle times means reduction of cost. Money is a primary motivator for many companies. Lack of clean water in Pakistan is a growing concern and it is becoming expensive and difficult to acquire. Saving water is a good selling point.

In the table above, the applications for the case company's products are analyzed by keeping the value they offer and the current environment in the Pakistani industry in view. Unlike the developed countries, in Pakistan hygiene and environmental issues are growing concerns but not the focus of many organizations. Like in many other developing countries, manufacturers focus on monetary aspects, which makes the CIP process application to be the most attractive as it offers benefits in terms of reducing cycle time, saving expensive chemicals and reducing the need for clean water which has become increasingly expensive in Pakistan. The figure below illustrates the technology lag in the dairy industry in Pakistan.

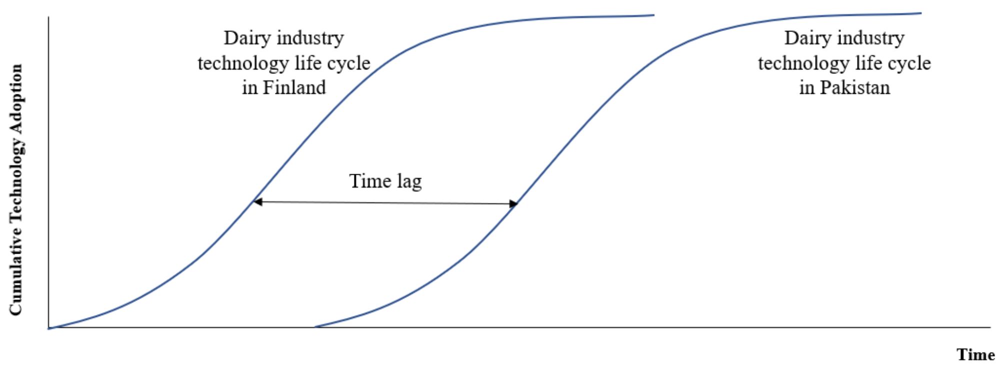

Figure 43. Technology lag in the dairy industry of Pakistan.

Unlike the sugar industry, the dairy industry in Pakistan has not caught up to the technology level of the developing countries. This argument is supported by the analysis of the technology applications. Some technology applications do not offer good value propositions meaning that the industry and country has not developed enough to utilize the benefits offered by the technology. There is a time lag before the technology applications become attractive and by that time new technologies and their applications have created in the developing countries. The table below shows the summary of the market analysis for the dairy industry in Pakistan.

Table 27. Market analysis summary of dairy industry in Pakistan.

Industry Sector	Value of *K*	Sales Potential *(s)*	Life Cycle Stage in Pakistan	Number of Potential Customers in Pakistan	Actionable Potential	Technology Applications	Technologies with highest value proposition
Dairy Industry	5.345	9.847	Maturity	17	Yes	• Waste water management • Leakage control in heat exchangers • CIP optimization	CIP optimization – excellent value proposition Leakage control in heat exchangers – average value proposition

Based on the analysis done in this section, the case company should move ahead with finding a distributor in Pakistan to sell their products. The focus of their products should be primarily the food and beverage sector with the applications in the sugar industry and CIP process optimization solutions for dairy plants. This is where their value proposition is the strongest. As the food and beverage industry continues to evolve, environmental and hygiene will become growing concerns in the country, and then the industries will fully be able to utilize the value offered by the other applications which are waste water management and leakage control in heat exchangers. This directly supports the technology gap framework developed, these applications will become attractive once the local industry has evolved to a level of being able to fully use them. Incorporating the case company’s decision to enter the market with their dairy technologies can be made part of the market entry strategy where the distributor is encouraged to approach milk manufacturers first and then when the case company is ready, the sugar manufacturers can be targeted as potential clients as well.

7. DISCUSSION AND LESSONS LEARNT

7.1 Overview of the problem and framework

As the economies of developing countries grow, there is an increasing demand for products and services (Mulma, 2011). The supply to match the demand is met by either increasing domestic production or importing the required products (Vercammen & Schmitz, 1992). This change in demand is created by demand drivers; these demand drivers are usually changes in average income, total population, personal taste of consumers, price of associated goods, special interests, and future expectations of price (Samuelson & Nordhaus, 2011; Rittenberg & Tregarthen, 2009; Mulma, 2011).

Traditional methods of understanding and analyzing demand in a market segment include demand forecasting. The benefits of demand forecasting are well documented and include improved strategic decisions, production planning, inventory planning, service levels, customer satisfaction, ability to identify disruptive changes, and supply chain performance (Fisher et al, 1994; Barnet, 1998; Aviv, 2002; Vogel, 2014). However, it is important to note that these benefits are a result of accurate forecasts, and inaccurate forecasts can lead to bad strategic decisions leading to huge financial losses for the organization (Barnett, 1988). This thesis focuses on a new approach to analyzing the potential of a market segment by reviewing the industry and technology level in a developing country in comparison to that of a developed country.

In order to develop a framework for industry and technology evolution in developed and developing countries, a detailed review of literature was done regarding industry and technology evolution models. The industry life cycle model by Porter (1980) has dominated industry evolution literature due to its importance in strategic management decision making. It divides the industry evolution cycle in four stages of introduction, growth, maturity, and decline. Each stage differs from the other in terms of industry structure, R&D practices, number of competitors, production processes, and general strategies (Klepper, 1996). In Chapter 2.2 an in-depth analysis was done on the differences in each stage of the industry life-cycle model.

Understanding the difference in technology levels of a developing and developed country required reviewing the current technology evolution literature. Unlike the industry evolution literature which is dominated by the industry life cycle model by Porter (1980), the technology evolution literature has two separate frameworks, the macro view and the S-curve (Taylor & Taylor, 2012). While both models offer an excellent overview of how technology evolution works, the use of the S-curve model has been developed by authors using different variables on the X and Y axis. The S-curve model for technology evolution based on cumulative adoption of technology was chosen for the development of the thesis framework, as it offers more insight into behavior of customers that acquire the technology, which helps in determining the value proposition for the early adopters which in turn, have a big impact on the early majority (Rogers, 1983).

With a detailed review of the literature, the framework regarding technology lag could be developed. Based on the detailed empirical evidence presented by Fagerberg (1987) of 25 industrial countries, it was found that there is a close relationship between economic development and technology development. There is a clear distinction between countries that develop technologies and those that adopt it later through diffusion of knowledge (Pavitt & Soete, 1982). This allowed the development of the technology lag framework which is shown in the figure below, where some developing countries lag behind in technology level while others manage to catch-up to the developed world.

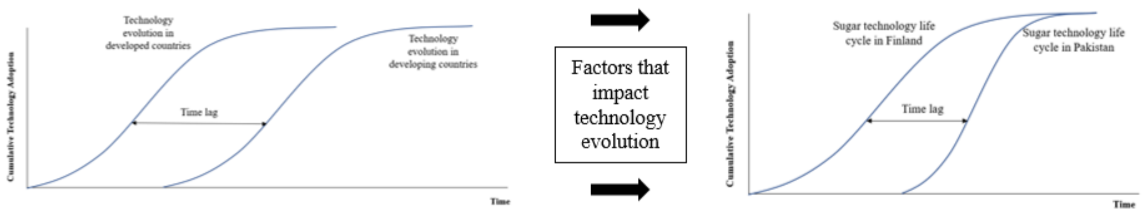

Figure 44. Framework of technology adoption lag between developing and developed countries.

While industry evolution and lag between countries has not been studied in literature like technology gap, the model developed above offers an excellent basis for creating an industry evolution time lag model. This model is shown in the figure below.

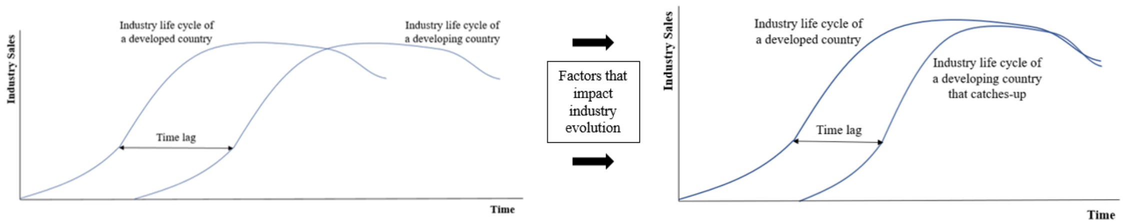

Figure 45. Framework for developing countries lagging behind developed ones in the industry life cycle.

The framework for technology and industry evolution gap offers benefits in terms of identifying where the developing countries stand in terms of overall development in technology level and industry growth. These are key insights for identifying which technologies offer the most value in the new geographical segment and choosing the right products to push into the market. As the developing country's market continues to evolve, other technologies can be focused on once the industry is developed to a point where it can utilize its offered value.

7.2 Reflection of the case in the framework

The case company recently started selling their products in India. After having a surprisingly good result, with higher than expected sales, they decided to explore other markets in the region with untapped potential. After some initial discussions regarding countries in South Asia and the Mid-East, it was decided that the focus of the thesis should be on Pakistan. The framework built in Chapter 5.2 was later used to evaluate the pulp and paper sector and the food and beverage sector with a focus on the sugar and dairy industry.

First the value of *K* was calculated based on the production figures of Finland and Pakistan. With the value of *K* and the overall annual production figures for the industries in Pakistan the value of *s* was estimated from the formula developed as part of the framework. After the value of *s* was calculated for each of the three industries the next step was analyzing the life cycle models and stages of these industries in Finland and Pakistan. Data was collected regarding annual production figures from both countries to create industry life cycle models. The market analysis was strengthened by identifying the number of competitors in the market. If the potential was actionable then the technology applications would be evaluated and the ones with the best value proposition would be used for market entry. The figure below shows how the casework for the pulp and paper industry was reflected in the developed framework.

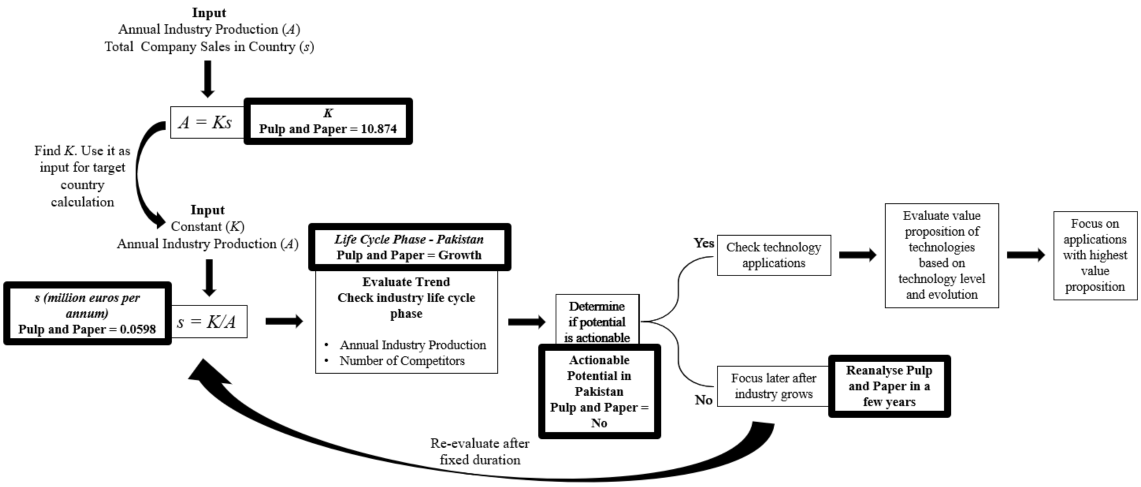

Figure 46. Reflection of pulp and paper analysis in the framework.

The figure above shows the model developed in Section 5.2 and how it was applied to the pulp and paper case work for this thesis. The boxes with the thick borders show the application of the case to the developed framework. The industry potential of the pulp and paper was found to be too low and the sector had just entered its growth phase. This was confirmed through the calculation of *s* and the industry life cycle analysis. Based on the framework it was suggested that the pulp and paper industry should be reanalyzed in a few years. The figure below follows the same structure and shows how the framework was applied to the analysis of the sugar industry in Pakistan,

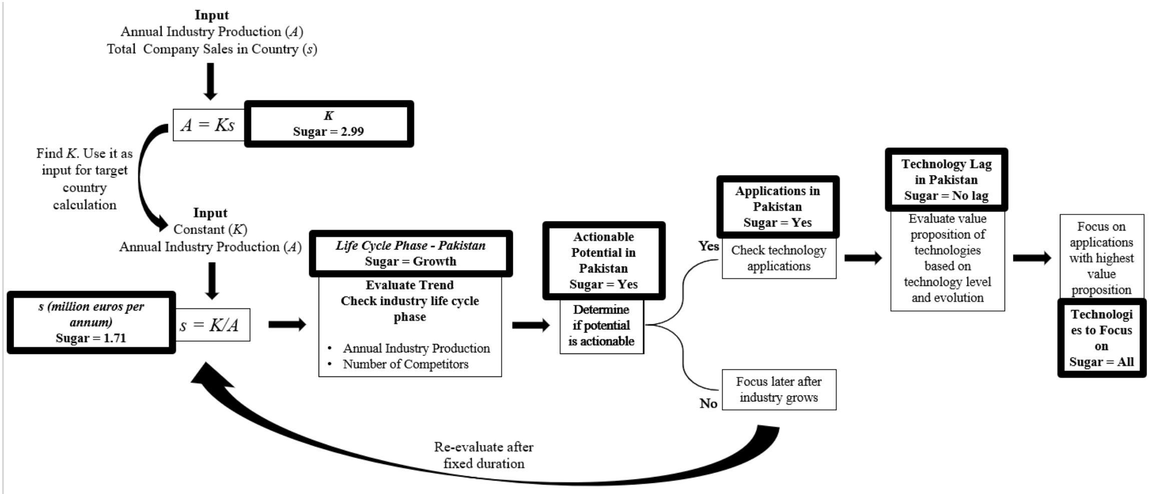

Figure 47. Reflection of sugar industry analysis in the framework.

Unlike the pulp and paper industry where the overall sales potential was found to be too low, the sugar industry showed very promising figures for potential sales, *s*. The life cycle phase analysis showed that Pakistani sugar industry was still in its growth phase due to growing production figures and the number of competitors also growing every year. Due to the potential being actionable, the technology evolution was evaluated, and it was found that the sugar industry in Pakistan has caught up to the developed countries in terms of technology level. On the case company's request, the technology applications were not explored as they wanted the focus to be on the dairy industry first. However, the technology evolution model suggests that if the case company wishes to sell their products to the sugar sector in Pakistan, all their applications would have excellent value proposition in the industry. The figure below shows the application of the framework to the analysis of the dairy industry in Pakistan.

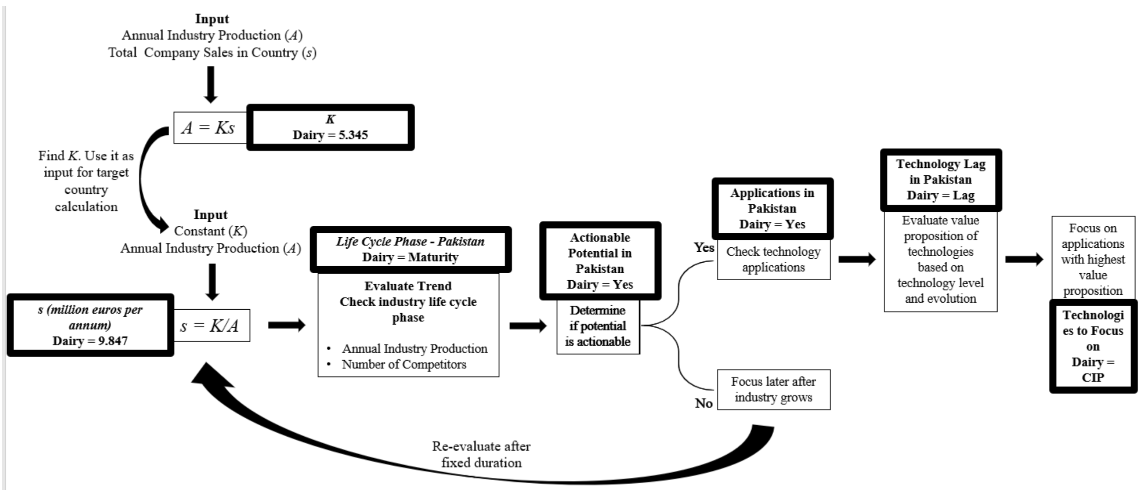

Figure 48. Reflection of dairy industry analysis in the framework.

The dairy industry like the sugar industry yielded promising figures in terms of sales potential, *s*. The production data available publicly for the dairy production was limited. However, it was enough to analyze the life cycle phase. Plotting annual production showed the dairy industry to be growing slowly and not keeping up with the total demand in the country, causing the level of imports to go up. The dairy industry also has a limited number of large scale competitors. All of these factors combined point to the dairy industry in Pakistan to be moving to the stage of maturity in its industry life cycle. The next step was the analysis of the technology level. The analysis of the technology level yielded a lag which hence led to the suggestion of developing a market entry strategy based on the CIP optimization process in the dairy industry. Other technologies could be focused on as the technology level evolves.

7.3 Analysis of case based on the framework

The framework itself was confirmed to be supported by empirical evidence by comparing the different industry sectors in Pakistan and Finland. The analysis generated very interesting results for the case company. Since the focus of the thesis was analyzing the Pakistani market to generate an understanding of applications for the case company's products, the results provided excellent grounds for generating a strategy for entering the Pakistani industry. The case company deals with three main industry sectors which are pulp and paper, food and beverage, and chemical. The figure below shows an analysis for the food and beverage and pulp and paper sectors based on the framework developed in this thesis.

Table 28. Analysis of Pakistani industry based on the developed framework.

Industry Sector	Industry Level Analysis	Technology Level Analysis
Pulp and Paper	• Low Potential based on low production volume • Market has just entered growth phase • Large industry evolution lag	• Technology level low, large lag in technology level
Food and Beverage	• Excellent potential • Sugar industry growing fast • Dairy industry entering maturity phase • Industry lag reducing, sector catching up	• Excellent potential for CIP application in dairy • Low potential for waste water monitoring and leakage control in heat exchangers because of technology gap. Good potential in coming years • Excellent potential in sugar industry

The figure above shows a summary of the analysis using the framework. The first sector to be analyzed was the pulp and paper, which yielded that there was a very large industry life cycle gap as the Pakistani industry had just entered its growth phase, while the industry in Finland was already in its final stage. The production volume was too low to offer significant potential worth investing time and money from the case company's perspective.

The next sector was the food and beverage industry. Since the Pakistani economy is heavily reliant on agriculture, the sector was promising even before the analysis. The analysis yielded interesting figures with Pakistan being the 5th largest producer of sugar and the 4th largest producer of milk in the world. The booming population and growing internal demand for these products makes the production steadily go up. Using the framework clarified that the dairy industry was already entering its maturity stage with production volume growing slower than local demand and the number of large scale competitors being less than 20. The sugar industry on the other hand, was still in its growth stage; the framework illustrated this by showing the growing annual production figures and the number of mills going up both of which are indicators of the growth phase. The figure below shows the summary of the steps as proposed by the framework.

Table 29. Summary of the steps proposed in the framework.

Industry Sector	Value of *K*	Sales Potential *(s)*	Life Cycle Stage in Pakistan	Number of Potential Customers in Pakistan	Actionable Potential	Technology Applications	Technologies with highest value proposition
Pulp and Paper	10.874	0.0598	Growth	100	No	Revisit when potential is actionable	Revisit when potential is actionable
Sugar Industry	2.99	1.71	Growth	89	Yes	Revisit when case company is interested	All technology applications
Dairy Industry	5.345	9.847	Maturity	17	Yes	• Waste water management • Leakage control in heat exchangers • CIP optimization	CIP optimization – excellent value proposition Leakage control in heat exchangers – average value proposition

The table above provides a concise summary of all the calculations and conclusions drawn based on the empirical work done in Chapter 6. It gives an overview of each sector was analyzed based on the framework.

7.4 Analysis of the results

The empirical study conducted in this thesis supported the developed framework that there is a lag in industry and technology evolution in developing and developed countries. While most industries in Finland are in stages of maturity or decline, the industries in Pakistan are in their growth phase or maturity phase. Like the pulp and paper industry and the sugar industry are in their growth phase and the dairy industry is entering the stage of maturity. Hence, the empirical work supports the developed framework that developing countries lag behind developed countries in the industry life cycle. This carries importance in terms of overall potential, as a simple demand forecast does not take into account the growing industry and hence growing potential in the region. Similarly, the demand forecast does not take into account the technology level of the target region. Pakistan is lagging behind in technology level in the dairy sector which is highlighted in the analysis of the food and beverage industry. While the CIP process offers an excellent value proposition, the industry is not technologically developed enough to reap the advantages in the waste water monitoring and leakage in heat exchanger applications. Both the dairy and sugar industry based on the market analysis have significant actionable potential. Based on the case company's preference, they should start off the market entry with focus on the dairy industry and then when they are ready, should introduce their product offering for the sugar industry.

At the beginning of the discussions for the thesis topic, the managers at the case company were not entirely convinced about Pakistan being a good potential region to focus their efforts on. The results of the analysis have changed their minds and now it is a region of significant interest for them due to its current and future potential. Discussions have moved from just thesis work to working with a distributor in the region that would be willing to sell their products to local companies.

The framework can be further strengthened by using future empirical work comparing different industry sectors of some other developing and developed countries other than Finland and Pakistan, which were the focus of this thesis.

8. CONCLUSION

In today's competitive business environment, many companies look for means of organic growth. One of the best ways to do this is by market expansion: selling their products in new geographical regions. While the idea itself is an excellent means to grow business and bring in new customers, it comes with its fair share of challenges. One of the biggest challenges which companies face when looking to sell in a new region is analyzing its business potential to judge if it is worth their time and money to sell in the specific location. Sales forecasts are traditional means to establish an estimate of the sales figures to make strategic decisions regarding the new region. While sales forecasts offer an excellent means to have an estimate, they do not look at all the variables involved in an evolving market such as developing countries.

The objective of the thesis was to develop a new approach to analyzing the market potential of a new geographical segment by utilizing industry and technology evolution models. The thesis focused on developing a theoretical framework regarding the time lag between industry and technology life cycles of a developed and a developing country. Due to limitations in the empirical study regarding data collection, and avoiding sensitive company information being shared, only publicly available data was used to support the theoretical framework and analyze the market segment which was Pakistan. The framework was also tested using the collected data for its viability.

The important findings of the thesis were that analyzing the market segment based on industry and technology evolution lag provides an excellent means to understand the demand in a developing economy. Theoretically, the thesis contributed in creating an industry life cycle lag model which has not been discussed in literature regarding industry evolution models and a framework for analyzing the market potential of a developing country which offers a more in-depth and dynamic look at the segment than a traditional forecast. The practical validity of the developed framework was proven by the results of the empirical study. The thesis offers as a much more in-depth approach to analyzing a market segment and providing information regarding which industries and technological applications offer the best value now and which applications can be left for later as the industry in Pakistan evolves. From a managerial perspective, the case company was surprised by the analysis based on the developed framework and decided to use it as a basis for seeking a distributor to enter the market. As a managerial tool, the framework offers a very systematic way to look at a target market to see the sales potential of a new geographical region.

Despite the interesting and practical results achieved from the empirical study using the developed framework, there are some limitations. Since the study was conducted using limited publicly available data, more information could be used to develop more extensive models. Moreover, the thesis framework was tested only for the industries in Pakistan and Finland; it remains to be seen if it can be applied to other developing and developed countries. Hopefully, in the future more research will be conducted in the area to check for the robustness of the model to test its practical application in industrial sectors other than pulp and paper and food and beverage while using different developing and developed countries.

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